

Water Quality and Biological Characteristics of Montana Streams in a Statewide Monitoring Network, 1999-2005

Comprehensive Report

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Montana's 305(b)/303(d) Water Quality Integrated Report
(Status and Trends)**

Disclaimer



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2.0 EXECUTIVE SUMMARY

Streams and rivers are important resources that are vital to Montana's economy and are valued for recreation including fishing, swimming and boating. They are also valued for providing drinking water and for supporting other beneficial uses such as agriculture, industry and aquatic life. Increases of human population in Montana will likely increase the demand of future land and water uses and affect the water quality and quantity of our streams and rivers. Our intent for establishing a statewide water quality monitoring (SWM) network was to provide resource managers and the public a consistent and long-term source of information on water quality status and trends so that they could make better-informed decisions about these important resources.

This comprehensive report provides information on the water quality and biological characteristics of 53 sites that are located on major streams and rivers throughout the State of Montana and includes the following technical reports:

- [Water-quality characteristics of Montana streams in a statewide monitoring network, 1999-2003.](#) This report describes the water quality, flow and loading characteristics.
- [Summary of aquatic invertebrate data from the Montana statewide monitoring network, 2001-2005.](#) This report provides an analysis and interpretation of the macroinvertebrate communities.
- [Support of aquatic life uses at stations in the Montana statewide monitoring network based on features of benthic algae associations, 2001-2005.](#) This report provides an analysis and interpretation of the algae communities.
- [Invertebrate and periphyton assessment methods for Montana streams: A study of site ranking, variability, and method agreement in the statewide monitoring network.](#) This report compares macroinvertebrate and periphyton biological assessment results.
- [The Montana Department of Environmental Quality statewide monitoring project: Escherichia coli 2003-2005.](#) This report provides an analysis and interpretation of the bacteria results.

The technical reports are organized by three major drainage basins—Missouri, Yellowstone, and Columbia—and include the evaluation of data collected from sites on the mainstems and their major tributaries. In addition, the biological reports are organized by ecoregions.

This comprehensive report also includes information on the amount of trace metals found in the bed sediments, and includes site summaries for each fixed-station site that was sampled. The site summaries provide a brief description and interpretation of the water quality and biological characteristics. Each site summary also includes a photo of the sampling location, a summary table with water quality information, and links to our databases. The intent of the site summaries is to present the information in a way where it can be easily used to evaluate the condition of a stream or river at that location. Site summaries can be accessed using the hyperlinks provided on a map of Montana ([Figure 4](#)).

3.0 INTRODUCTION

Streams and rivers are important and valued resources in Montana that are often impacted by land and water development. Demands on these water resources will increase over time as the population grows and associated resource development expands. For this reason, comprehensive baseline information is needed to evaluate stream and river conditions and make resource management decisions. To address this issue the Montana Department of Environmental Quality (MDEQ) partnered with the U.S. Geological Survey (USGS), Land and Water Consulting, Inc. and the University of Montana in 1998 to develop a statewide strategy to monitor the status and trends of stream and river water quality (Lambing 1999; Watson 2000; Anderson 2000).

The SWM network was initially implemented in 1999 and includes 53 fixed-station sites ([Figure 4](#) and [Table 2](#)). The network represents three major river basins in Montana—Missouri, Yellowstone, and Columbia—with sites located on mainstems and major tributaries. The data provided in this report were collected from 1999-2005. The report includes interpretations of the physical, chemical and biological data.

The SWM network was conceptually designed to be operated on a long-term and ongoing basis, pending availability of funding (Lambing, 1999; Anderson 2000; Watson 2000). The intent was to develop a statewide monitoring (SWM) network to collect and provide baseline water quality information that would assist in the development and implementation of effective water quality management plans for maintaining long-term beneficial uses of Montana streams. However, the network was temporarily discontinued in 2006, so that the data and information that were collected by the project could be evaluated. Future fixed-station monitoring will be dependant upon funding priorities.

4.0 PURPOSE AND SCOPE

Montana's SWM network was implemented by the MDEQ and USGS in 1999 to help meet Clean Water Act (CWA) requirements to monitor, assess and report to the public on the condition of State waters ([40 CFR 130.4\(a\)](#); [40 CFR130.8\(b\)\(1\)](#)). The network was designed to help meet the following objectives:

- Document large stream and river baseline water-quality conditions.
- Track annual variations in water quality and biological conditions.
- Establish a baseline dataset that could be used for future assessment of long-term trends in water quality.
- Evaluate attainment of water quality standards.
- Identify locations in need of additional attention.
- Provide background data for planning and evaluating water quality standards and assessment methods.
- Inform the general public about the water quality of Montana's large streams and rivers.

Chemical, physical and biological data were collected from most of the large streams and rivers that are located in Montana. This comprehensive report provides an analysis and interpretation of the water quality and biological data that were collected from 1999-2005.

5.0 DESCRIPTION OF THE STUDY AREA

The fixed-station sites within the SWM network are distributed within the Missouri, Yellowstone, and Columbia River basins in Montana and are located within the Rocky Mountain, Intermountain Valley and Prairies Foothill, and Plains [Ecoregions](#)¹ (Figures 1 and 2). The water quality and biological data and interpretations are segregated by these major river basins and ecoregions. The interpretations are based on water quality standards and criteria which vary on the water use classifications (Figure 3 and Table 1). Specific surface water use classifications can be found at [ARM 17.30.601 et seq.](#) Additional detailed descriptions of the study area are available within the technical reports.

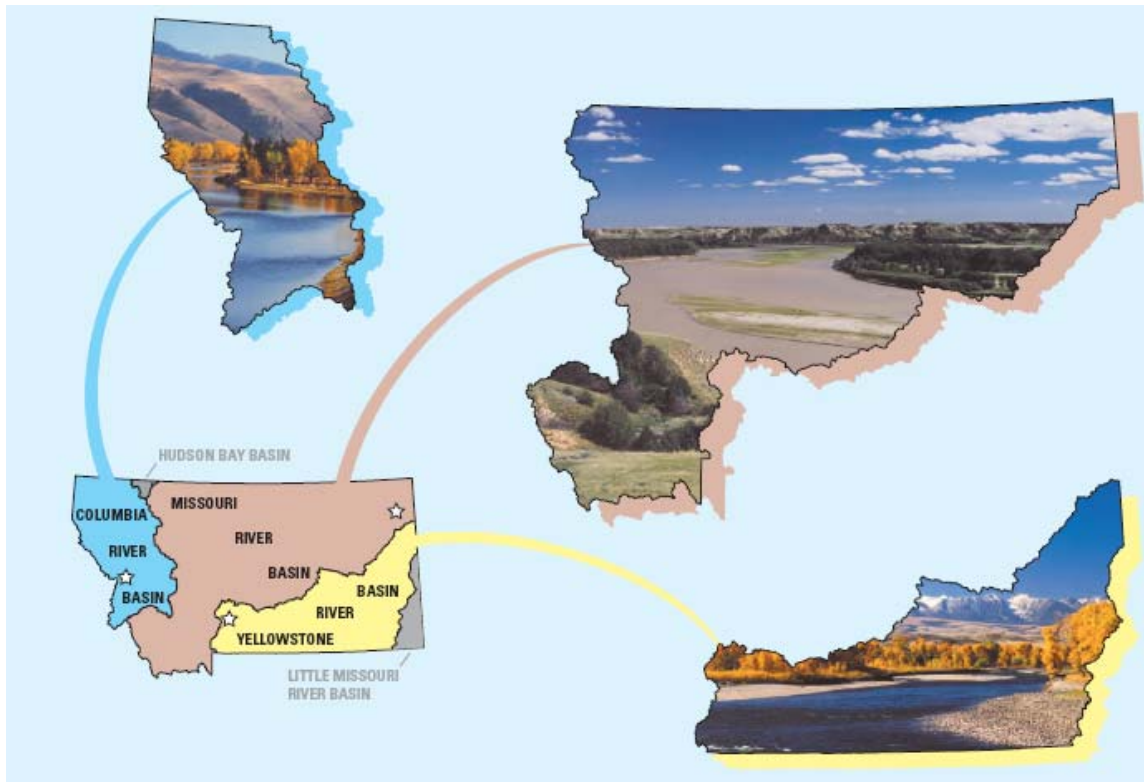


Figure 1. Montana River Basins (Source: Lambing and Cleasby 2006)

¹ (Woods et al. 1999) The ecoregions have been revised by U.S. EPA and no longer includes the Intermountain Valley and Prairie Foothills Ecoregion.

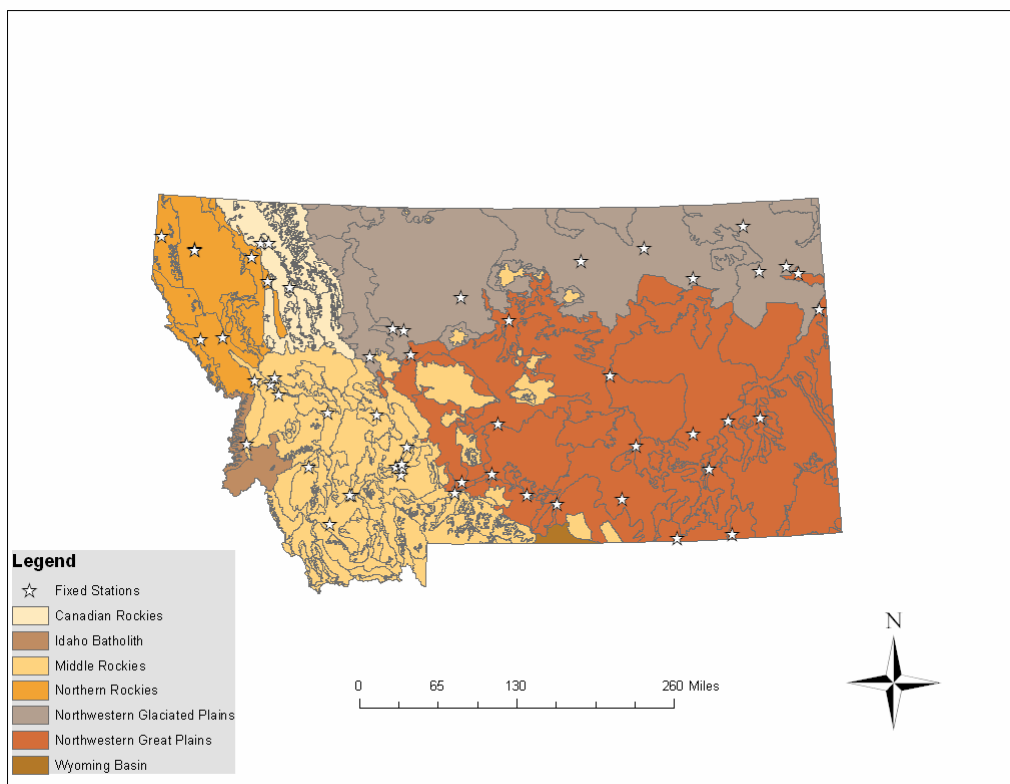


Figure 2. Montana Ecoregions

For more information see http://www.epa.gov/wed/pages/ecoregions/level_iii.htm

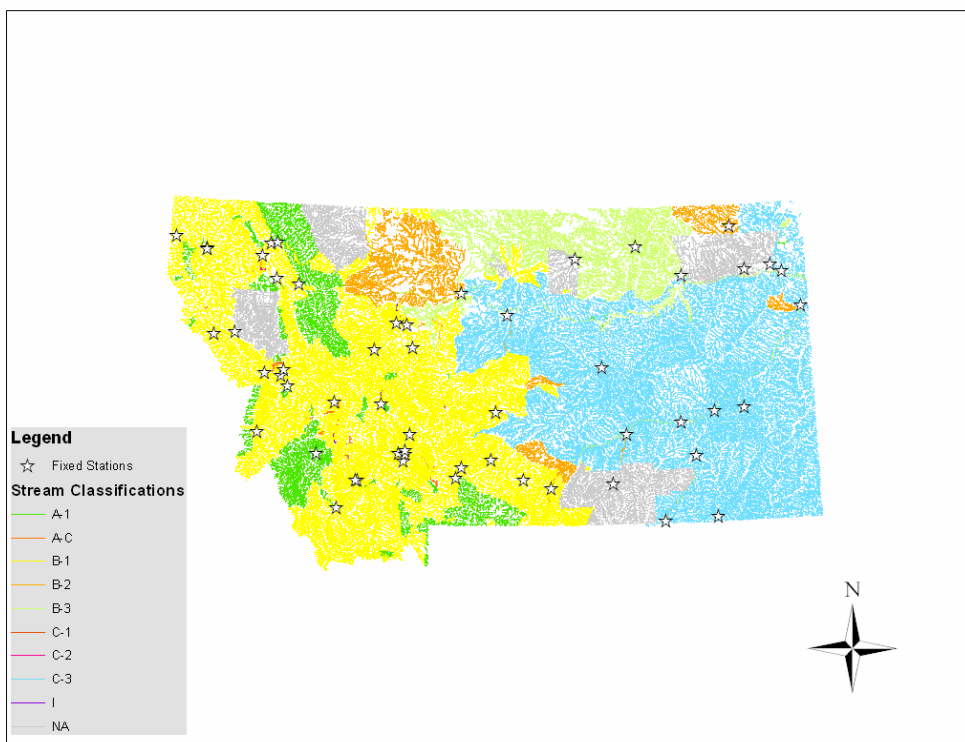


Figure 3. Montana Surface Water Use Classifications

Table 1. Surface water use classifications for streams that were sampled by the statewide monitoring network.

Stream Class	Designated Uses
A-1	Waters classified A-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities. Water quality must be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-1	Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-2	Waters classified B-2 are to be maintained suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-3	Waters classified B-3 are to be maintained suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-1	Waters classified C-1 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-3	Waters classified C-3 are to be maintained suitable for bathing, swimming and recreation, and growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agriculture and industrial water supply. Degradation which will impact established beneficial uses will not be allowed.

6.0 DATA COLLECTION AND ANALYSIS

6.1 Design of the Statewide Monitoring Network

The SWM network was designed to provide a systematic measure of water quality and biological condition that would allow for characterization of current conditions of large streams and rivers across the State, as well as provide a reference to assess changes over time. Sites were selected to represent the upper and lower mainstem segments of the three major river basins in Montana — Missouri, Yellowstone, and Columbia—and major tributaries to these rivers (Figure 4). Sites were monitored by USGS at locations that had active USGS streamflow gaging stations that provided quantitative streamflow information to enhance the ability to understand how water quality varies in response to changing flow. These fixed-station sites are considered to be integrator sites and were chosen to reflect the cumulative condition of the entire watershed. DEQ added several supplementary sites to the SWM network in 2002 and 2003 that were either at ungaged locations or were upstream from an integrator site to help determine how water quality and biological conditions changed from upstream to downstream locations. Biological sampling occurred at most of the sites within the SWM network.

A pilot study was conducted in 1999 by DEQ and the USGS National Water Quality Assessment Program (NAWQA) to compare and evaluate biological sampling methods. In 2000, the pilot study results were used to select the biological sampling methods for the SWM network (Bahls 2000; Pfeiffer et. al. 2000; Watson 2000). The methods that were chosen were utilized during the 2001-2005 field seasons to collect macroinvertebrate, periphyton and chlorophyll data at most of the fixed-station sites (excluding large rivers).

A total of 53 fixed-station sites were monitored by the SWM network (Figure 4 and Table 2). The USGS monitored water quality and flow at 38 integrator sites from 1999-2003 at least three times per year during spring runoff and once during the summer when the stream was at or near baseflow conditions. The USGS analyzed the water quality samples for common ions, nutrients and trace metals. They also collected continuous water temperature data at 26 sites from April through September. Most of the integrator sites and fifteen additional sites were also monitored by DEQ from 2001-2005 to assess biological conditions and to collect additional water quality data. More detailed information about the data collection efforts are provided in Table 2.

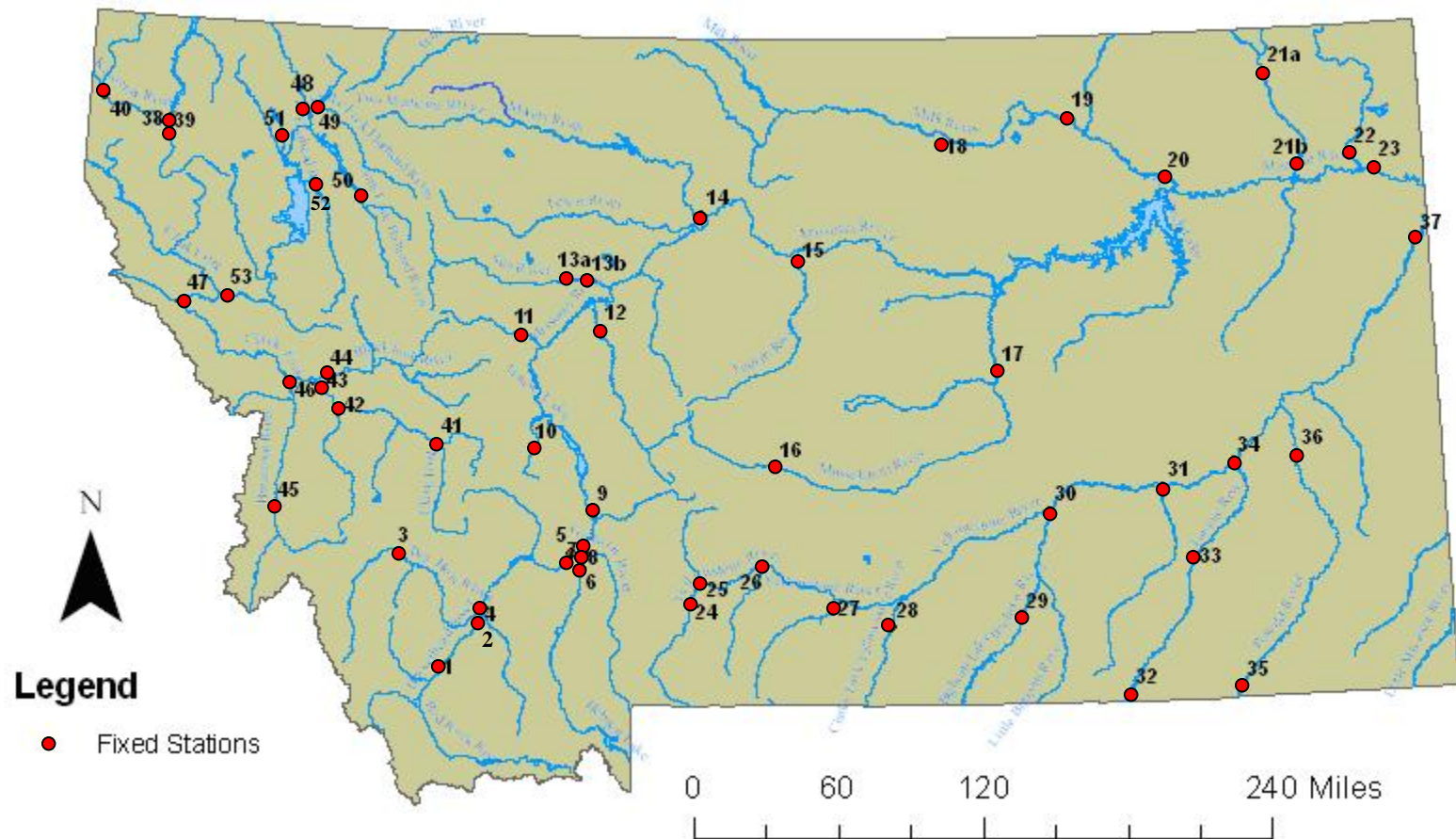


Figure 4. Map of Montana with fixed-station site locations. (Site locations are identified in Table 2 and site summaries can be viewed by clicking the site locations on the map)

Table 2. Site identification and data collected by the Montana statewide monitoring network

Basins	Site #	STORET / USGS Station ID	Waterbody	Parameters
Missouri River Basin	1	M02BVHDR01	Beaverhead River near Dillon	B, C, M, P, WQ2
	2	M08BEAVR01	Beaverhead River at Twin Bridges	B, C, M, P, T, WQ2
	3	M03BGHLR01	Big Hole River near Wise River	B, C, M, P, WQ2
	4	M03BGHLR02	Big Hole River near Twin Bridges	B, C, M, P, WQ2
	5	M08JEFFR01	Jefferson River near Three Forks	B, C, M, P, S, T, WQ1, WQ2
	6	M06MADNR01	Madison River near Three Forks	B, C, M, P, WQ2
	7	M05GALLR01	Gallatin River at Logan	C, M, P, S, T, WQ1 X
	8	M05GALLR02	Gallatin River near Three Forks	B, C, M, P, WQ2
	9	M09MISSR01	Missouri River near Toston	T, WQ1, X
	10	M09PRPEC01	Prickly Pear Creek near Clancy	B, C, M, P, S, WQ1, WQ2
	11	M12DRBNR01	Dearborn River at Craig	B, C, M, P, S, T, WQ1, WQ2
	12	M10SMTHR01	Smith River at Eden Bridge	B, C, M, P, WQ2
	13a	M13SUNR01	Sun River at Sun River	B, C, M, P, WQ2
	13b	USGS06089000	Sun River near Vaughn	T, WQ1
		M14TETOR01	Teton River near Loma	C, M, P, S, X
	14	M14TETOR02	Teton River near Loma - 1/4 mi upstream from rec site	B, C, M, P, S, T, WQ1, WQ2
	15	M22JUDR01	Judith River 2 mi u/s confluence w/ Missouri R	B, C, M, P, T, WQ1, WQ2
	16	M24MUSSR01	Musselshell River at Harlowton	B, C, M, P, WQ2
	17	M28MUSSR01	Musselshell River near Mosby	B, C, M, P, S, T, WQ1, WQ2
	18	M37PEOPC01	Peoples Creek near Dodson	C, M, P, WQ1, X
	19	M45MILKR02	Milk River at Bjornberg Bridge	C, M, P
	20	M45MILKR01	Milk River at Nashua	B, C, M, P, S, T, WQ1, WQ2
	21a	M47POPR01	Poplar River near Scoby	B, C, M, P, S, WQ2
	21b	USGS06181000	Poplar River at Poplar	T, WQ1
	22	M50BMDYC01	Big Muddy Creek near Culbertson	C, M, P, X
	23	M51MISSR01	Missouri River near Culbertson	P, T, WQ1, X
Yellowstone River Basin	24	Y03YELLR01	Yellowstone River near Livingston	C, M, P, T, WQ1, X
	25	Y03SHIER01	Shields River near Livingston	B, C, M, P, S, T, WQ1, WQ2
	26	Y03BOULR01	Boulder River at Big Timber	B, C, M, P, S, T, WQ1, WQ2
	27	Y04STILR01	Stillwater River near Absarokee	B, C, M, P, S, T, WQ1, WQ2
	28	Y05CLFYR01	Clarks Fork of Yellowstone at Edgar	B, C, M, P, S, T, WQ1, WQ2
	29	Y11BGHNR01	Bighorn River near Hardin	B, C, M, P, WQ2
	30	Y17BIGH01	Bighorn River at Bighorn	B, C, M, P, S, T, WQ1, WQ2
	31	Y17ROSEC01	Rosebud Creek at Rosebud	B, C, M, P, S, WQ1, WQ2
	32	Y15TONGR01	Tongue River near Stateline	C, M, P, X
	33	Y16TONGR01	Tongue River near Brandenburg	B, C, M, P, WQ2
	34	Y17TONGR01	Tongue River at Miles City	B, C, M, P, S, T, WQ1, WQ2
	35	Y18POWDR01	Powder River near Moorhead	B, C, M, P, WQ2
	36	Y21POWDR01	Powder River near Locate	B, C, M, P, S, WQ1, WQ2
	37	Y23YELLR01	Yellowstone River at Sidney	C, M, P, WQ1, X
Columbia River Basin	38	K01KOOTR01	Kootenai River near Libby Dam	C, M, P, T, WQ1, X
	39	K02FISHR01	Fisher River near Libby	B, C, M, P, S, WQ1, WQ2
	40	K01YAAKR01	Yaak River near Troy	B, C, M, P, S, T, WQ1, WQ2
	41	C01LTBLR01	Little Blackfoot River at Garrison	B, C, M, P, S, T, WQ1, WQ2
	42	C02ROCKC01	Rock Creek near Clinton	B, C, M, P, S, WQ1, WQ2
	43	C02CKFKR02	Clark Fork River at Turah Fishing Access	B, C, M, P, S, WQ1, WQ2
	44	C03BLACR01	Blackfoot River near Bonner	B, C, M, P, S, T, WQ1, WQ2
	45	C05BITRR01	Bitterroot River near Darby	B, C, M, P, WQ2
	46	C05BITTR01	Bitterroot R near Missoula abv bridge on N Ave	B, C, M, P, S, T, WQ1, WQ2
	47	C04CKFKR01	Clark Fork River at St Regis	B, C, M, P, S, WQ1, WQ2
	48	C06NFKFR01	NF Flathead River near Columbia Falls	B, C, M, P, S, WQ1, WQ2
	49	C07MFKFR01	MF Flathead River near West Glacier	B, C, M, P, S, WQ1, WQ2
	50	C08FRSFK01	SF Flathead River near Spotted Bear	B, C, M, P, WQ2
	51	C09WHTFR01	Whitefish River near Kalispell	B, C, M, P, S, WQ1, WQ2
	52	C10SWANR01	Swan River near Bigfork	B, C, M, P, S, T, WQ1, WQ2
	53	C12FLATR01	Flathead River near Perma	C, M, P, T, WQ1, X

- B = 2003-2005 Bacteria data collected by DEQ one time per year.
- C = 2001-2005 Chlorophyll data collected by DEQ one time per year
- P = 2001-2003 Periphyton data collected by USGS one time per year.
- M = 2001-2005 Macroinvertebrate data collected by DEQ one time per year.
- S = 2001 Sediment metals data collected one time per year.
- T = 1999-2003 Continuous temperature data collected during the summer by USGS.
- WQ1 = 1999-2003 Water quality data collected by USGS four times per year.
- WQ2 = 2004-2005 Water quality data collected by DEQ one time per year
- X = Biological monitoring abandoned

6.2 Methods of Sampling Collection, Processing, and Analysis

The USGS collected and analyzed water quality samples for common ions, nutrients and trace metals at 38 integrator sites following USGS protocols (Lambing and Cleasby 2006). In addition, DEQ collected field chemistry and habitat data; and water column, bed sediment, chlorophyll, bacteria, attached-algae (periphyton) and macroinvertebrate samples using the following DEQ standard operating procedures (SOPs):

- [Field Chemistry](#) – SOP 11.7.1; *Horiba Water Quality Checker – auto calibration*
- [Water Column](#) – SOP 11.9.1; *Grab Samples (Streams)*.
- [Bed Sediment](#) – SOP 11.8.5; *Sediment Collection for Trace Metal Analysis*
- [Chlorophyll](#) – SOP Revision WQPBWQM-011; *2.1 Rock Sampling Method*.
- [Bacteria](#) – SOP Revision WQPBWQM-014- Sample Collection, Handling and Analysis of *Escherichia Coli*
- [Periphyton](#) - SOP 12.1.2.1; *Field observations*; *SOP 12.1.2.4 Composition and Structure*
- [Macroinvertebrates](#) - SOP Revision WQPBWQM-009: *2.1 Hess Sampling Method*: Four composite Hess samples were used for sites that had riffle/run prevalence. *2.2 Traveling Kick Net Method*: The traveling kick net method was used for sites that had glide/pool prevalence. *Attachments 2 and 3* – macroinvertebrate habitat assessment forms were filled out each year for all sites where macroinvertebrates were sampled.

Field chemistry measurements were taken and chlorophyll and macroinvertebrate samples were collected by DEQ once each year during the summer from 2001-2005. Attached-algae samples were collected once each year during the summer from 2001-2003. Replicate bacteria samples were collected from each site once each year during the summer from 2003-2005. Composite bed-sediment samples were collected once in 2001 for trace metals analyses. Water column samples were collected by DEQ during 2004 and 2005 at the same time biological samples were collected. All water column, chlorophyll and bed-sediment samples that were collected by DEQ were analyzed by the Montana Department of Public Health and Human Services (DPHHS) Environmental Laboratory. Macroinvertebrate samples were analyzed by Rhithron Associates. Attached-algae (periphyton) samples were analyzed by *Hanna*.

6.3 Quality Assurance

A [sampling and analysis](#) plan was written for collecting field data and samples following DEQ's standard operating procedures. Duplicate samples were collected each field season. Field equipment was calibrated each day. Data were reviewed by the project and quality assurance officers. Field personnel were trained and field audits were conducted by professional staff. A chain-of-custody form was used to document the delivery of biological and water quality samples to the laboratories. The USGS followed their own quality assurance protocols for collecting and analyzing the chemistry samples. The State Environmental Laboratory followed their quality assurance program manual (revision 4) for the water quality samples that were collected by DEQ (DPHHS 2003). The biological laboratories followed their individual quality assurance protocols for analyzing the biological samples that were collected by DEQ.

7.0 SITE SUMMARIES

Site summaries were written that describe the water quality and biological characteristics for each fixed-station site. They can be viewed by using the hyperlinks that are provided on a map of Montana ([Figure 4](#)).

The primary objective of the Clean Water Act (CWA) is to restore and maintain the chemical, physical and biological integrity of the Nation's waters. For this reason, DEQ generally conducts stream assessments by evaluating a combination of chemical, physical and biological data ([See Water Quality Assessment Process and Methods](#)). Hence, this report provides a summary of the chemical, physical and biological data for each site.

Biological integrity is defined as the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region (Karr and Dudley 1981). Often the focus of a stream assessment is to evaluate the biological integrity. This is because the assessment of biological integrity provides a direct measure of aquatic life beneficial uses. The assessment of biological communities is also used to help identify water quality stressors. For example, an evaluation of the biological community often reveals when nutrients, sediment, temperature, or toxic metals are causing water quality degradation. For this reason, interpretations of the biological data are included within the site summaries. Brief interpretations of the chemistry and physical conditions are also provided in the site summaries and in Appendices B and C.

The site summaries provide information about the stream's chemical, physical, and biological integrity. This information can be used in combination to evaluate the condition of the stream at the location where the information was collected. The site summaries include a brief interpretation of the water quality and biological conditions, a table that provides physical and water quality data, and a photo of the sampling location. In addition, the site summaries include hyperlinks to EPA's STORET Data Warehouse, the USGS National Water Information System database and the Montana Fisheries Information System database. There is also a hyperlink to Montana's 305(b)/303(d) water quality assessment database which provides the impairment status for the stream that was sampled. Water quality standards can also be accessed within the site summaries through the hyperlinks: [Information on Impairment Status / Water Quality Standards/](#).

8.0 TECHNICAL REPORTS

This comprehensive report includes five technical reports that describe and interpret the water quality and biological characteristics of the fixed station sites that were sampled by the Statewide Monitoring Network. Additional technical reports may be added in the future. The following provides the citations, summaries and hyperlinks for the technical reports. The summaries within this report are copied from the technical reports.

8.1 Water Quality Report

[Lambing J. H. and T. E. Cleasby 2006. Water-quality characteristics of Montana streams in a statewide monitoring network, 1999-2003: U. S. Geological Survey Scientific Investigations Report 2006-5046, 149 p.](#)

Summary

A statewide monitoring network of 38 sites was operated during 1999-2003 in cooperation with the Montana Department of Environmental Quality to provide a broad geographic base of water-quality information on Montana streams. The purpose of this report is to summarize and describe the water-quality characteristics for those sites. Samples were collected at U.S. Geological Survey streamflow-gaging stations in the Missouri, Yellowstone, and Columbia River basins for stream properties, nutrients, suspended sediment, major ions, and selected trace elements. Mean annual streamflows were below normal during the period, which likely influenced water quality.

Continuous water-temperature monitors were operated at 26 sites. The median of daily mean water temperatures for the June-August summer period ranged from 12.5 °C at Kootenai River below Libby Dam to 23.0 °C at Poplar River near Poplar and Tongue River at Miles City. In general, sites in the Missouri River basin commonly had the highest water temperatures. Median daily mean summer water temperatures at four sites (Jefferson River near Three Forks, Missouri River at Toston, Judith River near Winifred, and Poplar River near Poplar) classified as supporting or marginally supporting cold-water biota exceeded the general guideline of 19.4 °C for cold-water biota. Median daily mean temperatures at sites in the network classified as supporting warm-water biota did not exceed the guideline of 26.7 °C for warm-water biota, although several sites exceeded the warm-water guideline on several days during the summer.

Nutrient concentrations generally were lower in the Columbia River basin compared to the Missouri and Yellowstone River basins. Dissolved nitrite plus nitrate concentrations did not exceed the State of Montana human-health standard for drinking water of 10 milligrams per liter (mg/L) nitrate as nitrogen (N) at any site in the network. Total nitrogen concentrations at network sites ranged from 0.043 to 31.6 mg/L as N and exceeded the ecoregion guideline of 1.50 mg/L for the prevention of eutrophication at several sites in the Missouri and Yellowstone River basins. In the Columbia River basin, concentrations of total nitrogen exceeded the State of Montana seasonal numeric standard of 0.300 mg/L in about 25 percent of the samples from two sites on the Clark Fork. Total phosphorus concentrations ranged from <0.01 to 15.4 mg/L; concentrations at most sites in the Missouri and Yellowstone River basins occasionally to frequently exceeded both the general and ecoregion eutrophication guideline concentrations of

0.10 and 0.075 mg/L, respectively. Total phosphorus concentrations at sites in the Columbia River basin only infrequently exceeded the general eutrophication guidelines. About 75 percent of the samples collected at Clark Fork at Turah Bridge and about 25 percent of the samples collected at Clark Fork at St. Regis exceeded the seasonal reach-specific numeric standards of 0.020 mg/L and 0.039 mg/L, respectively, for total phosphorus.

Suspended-sediment concentrations varied widely at individual sites and among sites, ranging from 1 to 25,400 mg/L. Suspended-sediment concentrations commonly were lower in the Columbia River basin compared to the Missouri and Yellowstone River basins. Median suspended-sediment concentrations exceeded 100 mg/L at several sites in the Missouri and Yellowstone River basins; median concentrations in the Columbia River basin generally were less than 10 mg/L. Overall, Powder River near Locate had the highest suspended-sediment concentrations in the network, with concentrations exceeding 2,000 mg/L in 25 percent of the samples.

Dissolved-solids concentrations ranged from 23 to 6,200 mg/L across the network. Samples from several sites in the Missouri and Yellowstone River basins had distinctly elevated concentrations relative to other sites and occasionally to frequently exceeded a general irrigation guideline of 1,000 mg/L. Three sites (Musselshell River at Mosby, Rosebud Creek near Rosebud, and Powder River near Locate) exceeded the guideline in more than 75 percent of the samples. Three other sites (Peoples Creek near Dodson, Milk River at Nashua, and Poplar River near Poplar) exceeded the guideline in 25 to 50 percent of the samples. No other sites exceeded the general irrigation guideline for dissolved solids. Sodium adsorption ratio (SAR) values ranged from <0.1 to 12 across the network and exceeded a general irrigation guideline of 7 at several sites in the Missouri and Yellowstone River basins. SAR values at Rosebud Creek near Rosebud commonly exceeded and Powder River near Locate occasionally exceeded the numeric standards of 4.5 and 7.5, respectively, established for SAR in those watersheds during the irrigation season.

State of Montana human-health standards for drinking water for total-recoverable cadmium, chromium, and nickel were exceeded only infrequently by concentrations in samples from across the network; standards for copper and zinc were not exceeded. One or more sites in each of the three major river basins had sample concentrations that occasionally exceeded the human-health standard of 18 micrograms per liter ($\mu\text{g/L}$) for arsenic (revised standard is 10 $\mu\text{g/L}$). The arsenic standard was exceeded in almost all samples from Missouri River at Toston and in about one-half of the samples from Yellowstone River near Livingston. Both sites receive geothermal waters enriched in arsenic from Yellowstone National Park. Concentrations of total-recoverable lead in one or more samples from each major river basin occasionally exceeded the human-health standard of 15 $\mu\text{g/L}$ for lead; concentrations exceeded the standard in about 25 percent or more of the samples from Prickly Pear Creek near Clancy and Powder River near Locate.

Comparisons of trace-element concentrations to general aquatic-life standards (based on average hardness) indicate that chronic standards were exceeded infrequently at many of the network sites and acute standards were rarely exceeded. Aquatic-life standards for arsenic and chromium were not exceeded; chronic and acute standards for cadmium, nickel, and zinc were occasionally exceeded. In contrast, about one-half of the sites in the network had one or more samples with concentrations that exceeded either chronic or acute aquatic-life standards for copper. Chronic

and acute standards for copper were exceeded most commonly in samples from Clark Fork at Turah Bridge. About one-half of the sites had one or more samples with concentrations exceeding the chronic standard for lead; Prickly Pear Creek near Clancy exceeded the standard in about 50 percent of the samples.

General estimates of mean annual loads of selected constituents transported during 1999-2003 were used to assess relative contributions from upstream source areas compared to the load at the most downstream site on the mainstem. The largest mean annual loads of total ammonia plus organic nitrogen from upstream source areas in the Missouri, Yellowstone, and Columbia River basins, respectively, were transported past Missouri River at Toston (1,400 tons), Bighorn River near Bighorn (1,260 tons), and Clark Fork at St. Regis (1,290 tons). A similar pattern occurred for loads of total nitrogen. The largest mean annual loads of total phosphorus from upstream sources in each major river basin were transported past Missouri River at Toston (239 tons), Yellowstone River near Livingston (572 tons), and Clark Fork at St. Regis (183 tons). Suspended-sediment loads varied substantially among sites, with the largest mean annual loads from upstream sources in each major river basin transported past Milk River at Nashua (319,000 tons), Powder River near Locate (1,400,000 tons), and Clark Fork at St. Regis (146,000 tons). Dissolved-solids loads also varied widely among network sites, with the largest mean annual loads from upstream sources in each major river basin transported past Missouri River at Toston (682,000 tons), Bighorn River near Bighorn (1,410,000 tons), and Kootenai River below Libby Dam (1,230,000 tons).

Annual loads of trace elements were estimated for total-recoverable arsenic and copper, except for sites where a large number of samples had concentrations less than the laboratory reporting level. The largest mean annual arsenic loads from upstream sources in the Missouri, Yellowstone, and Columbia River basins, respectively, were transported past Missouri River at Toston (109 tons), Yellowstone River near Livingston (62.1 tons), and Clark Fork at St. Regis (9.53 tons). The Missouri River at Toston had a notably larger arsenic load than any other network site, with more than 90 percent being contributed by the Madison River basin, which receives large volumes of arsenic-enriched geothermal waters from Yellowstone National Park. Similarly, a large arsenic load was estimated for Yellowstone River near Livingston, which also receives geothermal waters from the Park. The largest mean annual copper loads from upstream sources in each major river basin were transported past Missouri River at Toston (13.6 tons), Yellowstone River near Livingston (18.8 tons), and Flathead River at Perma (34.8 tons).

8.2 Macroinvertebrate Report

[Bollman, W. 2006. Summary of Aquatic Invertebrate Data from the Montana Statewide Monitoring Network, 2001-2005. Rhithron Associates, Inc. Missoula, Montana](#)

Summary

Aquatic invertebrate samples and habitat assessment data were collected at 46 fixed stations from 2001 to 2005. Stations were part of the Montana statewide monitoring network, and were located in 3 ecoregions in the State: the Montana Valley and Foothill Prairies (MVFP) ecoregion, the Mountain ecoregions, and the Plains ecoregions. Sampling procedures, sample processing

and analysis, and habitat evaluation were conducted according to Montana Department of Environmental Quality (MDEQ) standard operating procedures. Two hundred and forty-eight taxa of aquatic invertebrates were identified from the 199 samples included in this study. Metric measures of taxonomic and functional composition, tolerance and sensitivity, physiology and habitus were calculated based on invertebrate assemblages identified in each sample. Certain metrics were integrated into established bioassessment indices and the resulting index score for each sample was compared to values representative of reference condition in each ecoregion. Three such indices were used in this study: the MVFP index (Bollman 1998), the MDEQ index for Mountain ecoregions (Bukantis 1998), and the Plains indices (Bramblett et al.) Comparisons were expressed as percent of maximum index score, and these were used to characterize biological integrity at each station. Mountain ecoregion sites were assessed with 2 indices (MVFP and MDEQ), and these results were compared. Geographic variation in index performance over ecoregions and watersheds was examined. When the MDEQ index was used, Mountain ecoregion sites yielded significantly lower scores than the Plains region or the MVFP. When the MVFP index was applied to the data, the Mountain region sites gave significantly higher scores than the other 2 regions. While there were no significant differences in mean assessment scores among ecoregions, watersheds did demonstrate differences. Watersheds also produced significantly different scores: the Columbia River basin produced the highest mean bioassessment score, and the Yellowstone River basin produced the lowest mean score. Temporal variation in index performance over the entire data set, as well as over each watershed and ecoregion, was also examined. There were no significant differences in mean bioassessment scores among years.

Sites were stratified by watershed and ecoregion, and ranked based on the characterizations of biologic integrity. Individual provisional metric indicators of specific stressors (sediment, nutrient enrichment, dewatering and/or thermal stress, and metals contamination) were examined to determine probable causes of impairment at each station. Water quality and habitat issues suggested by the invertebrate assemblages were summarized for each river basin.

Only 5 sites in the statewide monitoring network did not exhibit definitive provisional metric responses suggesting impairment by specific stressors. Two of these sites are located in the Missouri River basin: Big Hole River near Wise River and Judith River near mouth. The other 3 sites are located in the Yellowstone River basin: Boulder River near mouth, Stillwater River near Absarokee, and Tongue River near Brandenburg. Overall ranking of statewide stations placed North Fork Flathead River near Columbia Falls best among sites; Big Horn River near Hardin gave the worst result. Nutrient enrichment was the most frequently detected specific stressor (39 sites), followed by sediment deposition (18 sites). Effects associated with non-specific habitat disruption were noted at 45 sites.

Nutrient enrichment appeared to be the most common stressor of invertebrate assemblages in both the Missouri River and Columbia River basins. Sediment deposition appeared to be the most common stressor in the Yellowstone River basin. Evidence of stress which may have been due to dewatering and/or thermal extremes was commonly encountered among Yellowstone River basin sites. Metals contamination was detectable at a single site (Prickly Pear Creek near Clancy).

Habitat assessments were variable among years at each site; scores for Plains regions sites in both the Missouri and Yellowstone River drainages varied most from year to year. Scores for sites in the Columbia River basin were least variable among years. Montana Valley and Foothill Prairie (MVFP) ecoregion sites within the Yellowstone and Missouri River basins were more variable than MVFP sites in the Columbia River basin. Mean habitat assessment scores for all watersheds were significantly lower in 2003 than in other years. Similar to bioassessment results, the Columbia River basin produced the highest mean habitat assessment score, and the Yellowstone basin produced the lowest mean score.

8.3 Periphyton Report

[Bahls, L. 2006. Support of Aquatic Life Uses at Stations in the Montana Statewide Monitoring Network based on Features of Benthic Algae Associations, 2001-2005. Hannaes. Helena, MT](#)

Summary

Samples of benthic algae were collected at 53 statewide monitoring sites in Montana from 2001 through 2005. Two types of benthic algae samples were collected: (1) chlorophyll samples for estimating algal standing crop, and (2) periphyton samples for determining the taxonomic composition and structure of benthic algae associations. Periphyton and chlorophyll samples were collected and analyzed following MDEQ standard operating procedures. Selected algal association metrics, based on species composition and relative abundance, were generated from periphyton samples. Metric values were compared to established criteria (thresholds) to evaluate biological integrity, support of aquatic life uses, and possible cause(s) of impairment. Metric values for each site were standardized and averaged and sites were ranked based on these average standardized values. Provisional discriminant analysis models were also applied to ascertain probability and cause of impairment. Chlorophyll standing crop values were compared to MDEQ criteria for support of aquatic life and aquatic recreation uses. Water quality issues suggested by the benthic algae are summarized for each river basin.

Thirty-four genera of soft algae ranked 1st, 2nd or 3rd in biovolume in the 119 periphyton samples collected from statewide monitoring sites. The two most common groups of soft algae among the top three producers of biovolume were green algae (Chlorophyta) and cyanobacteria (Cyanophyta). Other groups, including red algae (Rhodophyta), yellow-green algae (Chrysophyta), and brown algae (Phaeophyta), were also present.

Diatoms (Bacillariophyta) were present in all 119 periphyton samples and they ranked 1st, 2nd or 3rd in biovolume in all but 6 of these samples. 513 diatom species in 89 genera were identified and counted. Only five sites in the statewide monitoring network were without stress as indicated by calibrated diatom metrics and all five of these sites are below dams. At the remaining sites, sediment was the most frequent identifiable cause of impairment (23 sites), followed by organic nutrients (17 sites), and metals (5 sites). Other causes of stress, including natural causes, were documented at 38 of the 53 sites.

Chlorophyll values that indicate nonsupport of aquatic recreational uses, including aesthetics, were measured at 13 sites. Partial support of recreational uses was indicated by chlorophyll standing crops at several other stations. Large chlorophyll standing crops suggest elevated concentrations of inorganic nutrients.

Among mountain streams in the Missouri River Basin, Dearborn River near Craig and Sun River at Sun River ranked highest in terms of average standardized metric scores. At the other end of the impairment spectrum, Prickly Pear Creek near Clancy rated poor. Among plains streams in the Missouri Basin, Missouri River near Culbertson and Musselshell River above Harlowton rated excellent and Musselshell River at Mosby and Big Muddy Creek near Culbertson rated poor. Four mountain streams in the Yellowstone River Basin rated excellent and only one stream—Clarks Fork River at Edgar—rated poor. Among plains streams in the Yellowstone River Basin, Tongue River near Brandenburg rated excellent, while Rosebud Creek near Rosebud and Powder River near Moorhead rated poor. Flathead River near Perma and Swan River near Bigfork rated excellent among mountain streams in the Columbia River Basin. At the bottom end of the list, Bitterroot River near mouth and Little Blackfoot River at Garrison rated poor.

Applying a provisional model for sediment increasers in the mountains, several sites in the upper Missouri River Basin had very high probabilities of impairment due to sediment on one or more sample dates. Only one site in the Yellowstone River Basin—Bighorn River near Hardin—had a similarly high probability of sediment impairment, but several sites had intermediate probabilities. In the Columbia River Basin, the Fisher River near mouth, Clark Fork River at Turah, and Clark Fork River at Saint Regis had the highest probabilities of sediment impairment.

Applying a provisional model for nutrient increasers in the mountains, many sites in the upper Missouri River Basin had very high probabilities of impairment due to nutrients on one or more sample dates. Most of these were the same sites that had high probabilities of sediment impairment. In the Yellowstone River Basin, the Shields River near mouth and the Tongue River near Brandenburg had the highest probabilities of nutrient impairment, followed by the Bighorn River at mouth and the Tongue River at Stateline. Several sites in the Columbia River Basin had very high probabilities of nutrient impairment: Fisher River near mouth, Little Blackfoot River at Garrison, Rock Creek near Clinton, Clark Fork River at Turah, Clark Fork River at Saint Regis, and Whitefish River near Kalispell.

Applying a provisional model for metals increasers in the mountains, many of the same sites that had very high probabilities for sediment and nutrient impairment also had very high probabilities for metals impairment. At least two of these sites—Clark Fork River at Turah and Clark Fork River at Saint Regis—have documented impairment by metals. In general, the probability of metals impairment was lower in the Yellowstone River Basin than in the Missouri and Columbia River Basins. Applying the combined list of general increasers in mountain streams, most sites in the statewide monitoring network showed a high to very high probability of impairment from one or more causes of impairment.

For general impairment increasers in the plains, the Teton River near Loma, Judith River near mouth, and Musselshell River above Harlowton had the highest probabilities of impairment,

followed by Tongue River near Brandenburg and Powder River near Locate. For general impairment decreases in the plains, several sites had very high probabilities of impairment: Teton River near Loma, Judith River near mouth, Musselshell River above Harlowton, Milk River at Nashua, Rosebud Creek near Rosebud, and Tongue River at Miles City. These were followed closely by the Missouri River near Culbertson and Yellowstone River near Sidney.

Among identifiable causes of impairment, inorganic nutrients are the most frequent and severe causes of impairment at monitoring stations in the Missouri River Basin. Sediment ranked next among other identifiable causes of impairment at Missouri Basin sites, followed in order of frequency and severity by organic nutrients and metals.

Sediment was the most frequent cause of impairment in the Yellowstone River Basin, followed by inorganic nutrients, other causes, and organic nutrients. Metals were detected as a cause at only 2 of the 14 sites in the Yellowstone Basin. In terms of severity, inorganic nutrients ranked first with an average impairment level between moderate and severe. Average levels of impairment for other causes, sediment, and organic nutrients were lower, ranging between minor and moderate. Metals had only a minor impact at the two stations where they were detected as a probable cause.

Inorganic nutrients were the most frequent and most severe of the identifiable causes of impairment in the Columbia River Basin. One or more exceedences of chlorophyll criteria occurred at 8 of the 16 sites in the Columbia Basin and the average level of impairment was between moderate and severe. Sediment, organic nutrients, and metals resulted in minor impairment at 6 sites, 2 sites, and 2 sites, respectively.

8.4 Comparison of Macroinvertebrate and Periphyton Assessment Methods

[Bollman, W. and M. Teply. 2006. Invertebrate and periphyton assessment methods for Montana Streams: A study of site ranking, variability, and method agreement in the statewide monitoring network. Rhithron Associates, Missoula, MT and Larix Systems, Helena, MT.](#)

Summary

Aquatic invertebrate samples, periphyton (diatom) samples, and habitat assessment data were collected at 46 fixed stations from 2001 to 2005. Stations were part of the Montana Statewide Monitoring network. Sampling procedures, sample processing and analysis, and habitat evaluation were conducted according to Montana Department of Environmental Quality (MDEQ) standard operating procedures (Bukantis 1998) which were current in those years. Taxonomic data were used to obtain impairment classifications for each site in each sampled year using 5 different assessment methods: 3 metric-based bioassessment tools, a predictive model, and a discriminant function analysis. The metric-based tools were 1) invertebrate multimetric indices (Historic MMI: Bollman 1998, Bukantis 1998, and Bramblett 2003) and 2) diatom multimetric indices (Diatom MMI: Bahls 1993) that were included in past MDEQ operating procedures for biologic assessment and 3) newly developed invertebrate indices (MMI: Jessup et al. 2006) recently adopted as standard procedure by MDEQ. The predictive model is based on comparisons between observed and expected invertebrate assemblages (RIVPACS:

Hawkins 2005) and has also been adopted for use by MDEQ. A discriminant function analysis based on the incidence of specific diatom taxa (Increaser Taxa: Teply and Bahls 2005) was the fifth tool applied in this study; among the assessment tools examined, it is the only one which has not been adopted by MDEQ either in the past or for current use.

Sites were ranked within major basins and ecoregions using mean bioassessment scores for all 3 invertebrate assessment tools over all years. The ranges of numeric scores of the invertebrate indices were compared; spatial variation in scores over site classes, ecoregions, and major watersheds was examined, and temporal variation in scores within each ecoregion and major watershed were described. For within-watershed comparisons, standardized scores from all 3 indices could be compared, but for within-ecoregion or within-site class comparisons, the different stratification methods limited the comparisons.

Statistical analyses were performed comparing the results of all assessments; specifically, these analyses were directed at finding out how often invertebrate and diatom assessments of impairment agree, overall as well as within ecoregions and site classes. These analyses also sought to elucidate whether any patterns could be distinguished to help explain why disagreements occurred.

In this report, the biologic conditions of Statewide monitoring sites in Montana as suggested by faunal characteristics of benthic invertebrate assemblages collected over 5 years are ranked and described. Spatial and temporal variation of Historic MMI, MMI, and RIVPACS results for the Statewide monitoring sites over the years of study is also illustrated. Finally, assessment results of the 3 benthic invertebrate models with assessments based on periphyton (diatom) biocriteria were compared, where diatom-based assessments were available.

Overall, assessment methods tend to yield impairment determinations that have generally “Poor” agreement with the MDEQ classifications. In many instances, kappa coefficients are negative indicating that agreement is less than would be expected just by chance. Only the Increaser Taxa yield determinations that have “Good” or “Very Good” agreement and this only occurs in the Mountains/Northern Rockies. Additionally, bioassessment results for the Statewide monitoring sites are considerably variable both spatially and temporally. Differences in site ordering by impairment between methods as well as variable performance within site classes and watersheds were evident, as well.

8.5 Bacteria Report

[Feldman, D. L. 2006. The Montana Department of Environmental Quality statewide monitoring project: *Escherichia coli* \(2003-2005\). Montana Department of Environmental Quality. Helena, MT.](#)

Summary

This study summarizes the results of *Escherichia coli* (*E. coli*) samples collected in Montana. Montana Department of Environmental Quality (DEQ) staff collected *E. coli* samples from the

State-Wide Monitoring (SWM) Network once every year from 2003 through 2005. We used a modified Colilert[®] method to measure *E. coli* densities at each site.

Samples from western Montana had the lowest *E. coli* densities. The densities were higher in samples from eastern Montana.

- Lowest: Columbia River Basin samples averaged 22 ± 9 Colony-Forming Units (CFU)/100 ml between 2003 and 2005.
- High: Missouri River Basin samples averaged 59 ± 103 CFU/100 ml.
- Highest: Yellowstone River Basin samples averaged 84 ± 131 CFU/100 ml.

Data in this study were highly variable. Replicate samples were collected from almost every station. In order to evaluate this variation, we calculated the Coefficient of Variations (CV) to evaluate basin-wide differences and Relative Percent Difference (RPD) to evaluate differences at the site between years:

- Lowest variability: Columbia River Basin (CV = 46%).
- Highest variability: Missouri Basin (CV = 62%).
- Also high: Yellowstone River Basin (CV = 61%).
- Highest replicate variability: Columbia River Basin (RPD = 11%)
- Lowest replicate variability: Missouri and Yellowstone River Basins (RPD = 9%)

Four sites exceeded the Montana *E. coli* single-sample standards of 252 CFU/100 ml – three sites in the Missouri River Basin and the one in the Yellowstone River Basin. These sites didn't exceed the standard every year. The remaining sites appeared to meet standards within the limitations of the dataset.

- Musselshell River at Mosby, a C-3 waterbody, exceeded the Montana standard in 2003 and 2005.
- Milk River sites at Bjornberg Bridge and Nashua, a B-3 waterbody, exceeded the standard in 2004.
- Rosebud Creek near Rosebud, a C-3 waterbody, exceeded the standard in 2003, and 2004.

9.0 SUMMARY OF ADDITIONAL WATER QUALITY DATA COLLECTED BY DEQ

All results for the biological samples collected by DEQ are provided within the technical reports. However, the water quality and bed-sediment chemistry data that were collected by DEQ were only summarized within the site summaries. Therefore, Appendices A and B provide the field water chemistry and bed-sediment metals data that were collected by DEQ but were not analyzed within the technical reports. Appendix D provides the common ions, metals and nutrient results for the water quality samples that DEQ collected in 2004 and 2005. Please note that the USGS also collected field water quality data (i.e., trace metals, nutrients, common ions, TSS, pH, specific conductance and temperature) at most of these fixed-station sites and that their dataset is much more extensive than DEQ's dataset. The USGS also included summaries and interpretations for these parameters within their water quality report. Therefore, summaries and interpretations for trace metals, nutrients, common ions, pH, TSS, specific conductance and temperature are not included here. All of the data that DEQ collected can be downloaded from the U.S. EPA STORET database. All of the data that USGS collected can be downloaded from the USGS database. Links to both of these databases are provided within the site summaries which can be accessed through hyperlinks on Figure 4.

9.1 Dissolved Oxygen

Dissolved oxygen data were collected by DEQ from 2001-2005 and ranged from 7.3 -14.4 (Appendix A). No violations of water quality standards were recorded. However, the dissolved oxygen measurements were not corrected for changes in barometric pressure. Also, because the meter was calibrated for sea level conditions the results will likely vary the most from their true values at sites that are located at high elevations. For these reasons, the measured results may be as much as 2 ppm higher than the true value.

9.2 Bed Sediment Metals

The Statewide monitoring network detected elevated metals in the bed sediment at five fixed-station sites (Appendix B). The elevated sites typically had at least twice the amount of trace metals (ug/g) than the other sites (Cu, Pb or Zn). These sites were the Jefferson River near Three Forks, Prickly Pear Creek near Clancy, Little Blackfoot River near Garrison, Clark Fork River at Turah and the Clark Fork River at St. Regis. All of these streams are known to have abandoned mines occurring within their watersheds and may be contaminated by trace metals.

Interestingly, a number of streams that were monitored by the SWM network that had exceedences of trace metal water quality standards did not have elevated trace metals in the bed sediment, especially within the Yellowstone River Basin. Apparently, many of these exceedences of Montana's water quality standards, which are based on total recoverable trace metals, were caused by large quantities of suspended sediment that may have resulted from natural sources (for more information see the site summaries).

10.0 DISCUSSION

The fixed-station network was designed to meet the following objectives:

- Document large stream and river baseline water-quality conditions.
- Track annual variations in water quality and biological conditions.
- Establish a baseline dataset that could be used for future assessment of long-term trends in water quality.
- Evaluate attainment of water quality standards.
- Identify locations in need of additional attention.
- Provide background data for planning and for evaluating water quality standards and assessment methods.
- Inform the general public about the water quality of Montana's large streams and rivers.

All of these objectives were met with the exception of establishing a baseline database that could be used for future assessment of long-term trends in water quality. The network was conceptually designed to be operated on a long-term and ongoing basis. However, due to limited funding only five years of data were collected and most of the data collections occurred when there was a severe drought. In addition, the water quality data collected by USGS and the macroinvertebrate and periphyton data collected by DEQ only occurred from 2001-2003. Consequently the short duration of the monitoring effort is likely to hamper the ability to use this dataset in the future to assess water quality trends.

The design of this project projected at least 10 years of systematic sampling was needed to detect statistically significant trends that might be attributed to factors such as climate or changing land or water-use activities (Lambing 1999; Anderson 2000; Watson 2000; Cleasby and Lambing 2006). Nevertheless, a smaller dataset could still be used to establish a baseline for detecting future trends if the sampling period represented the average ranges in climatic variation (wet and dry cycles). However, the data generated by this project were collected primarily during a dry cycle. Therefore, caution should be used when this dataset is used as a baseline for detecting trends for streams that were greatly influenced by the drought and for water quality parameters or indicators that are greatly influenced by wet and dry cycles.

The influence of drought on this dataset was evaluated by comparing the mean annual stream flow from 1999-2003 to the mean annual stream flow for a long-term period of record (Cleasby and Lambing 2006). This analysis established that the 1999-2003 dataset had stream flows that ranged from 12-91% of the average long-term periods of record. Table 3 provides the average and range in percentage of long-term mean annual stream flows for water years 1999-2003. The 2004 DEQ collection of biological and water quality data also occurred during a dry cycle for most of Montana (Figure 5). The 2005 DEQ collection of biological and water quality data occurred during a wetter cycle for most of Montana (Figure 6).

Table 3. Average and range in percentage of long-term mean annual stream flow for years 1999-2003

River Basin	Average and range in percentage of long-term mean annual stream flow for water years 1999-2003
Missouri	Average = 59% Range = 12-80%
Yellowstone	Average = 69% Range = 40-89%
Columbia	Average = 84% Range = 68-91%

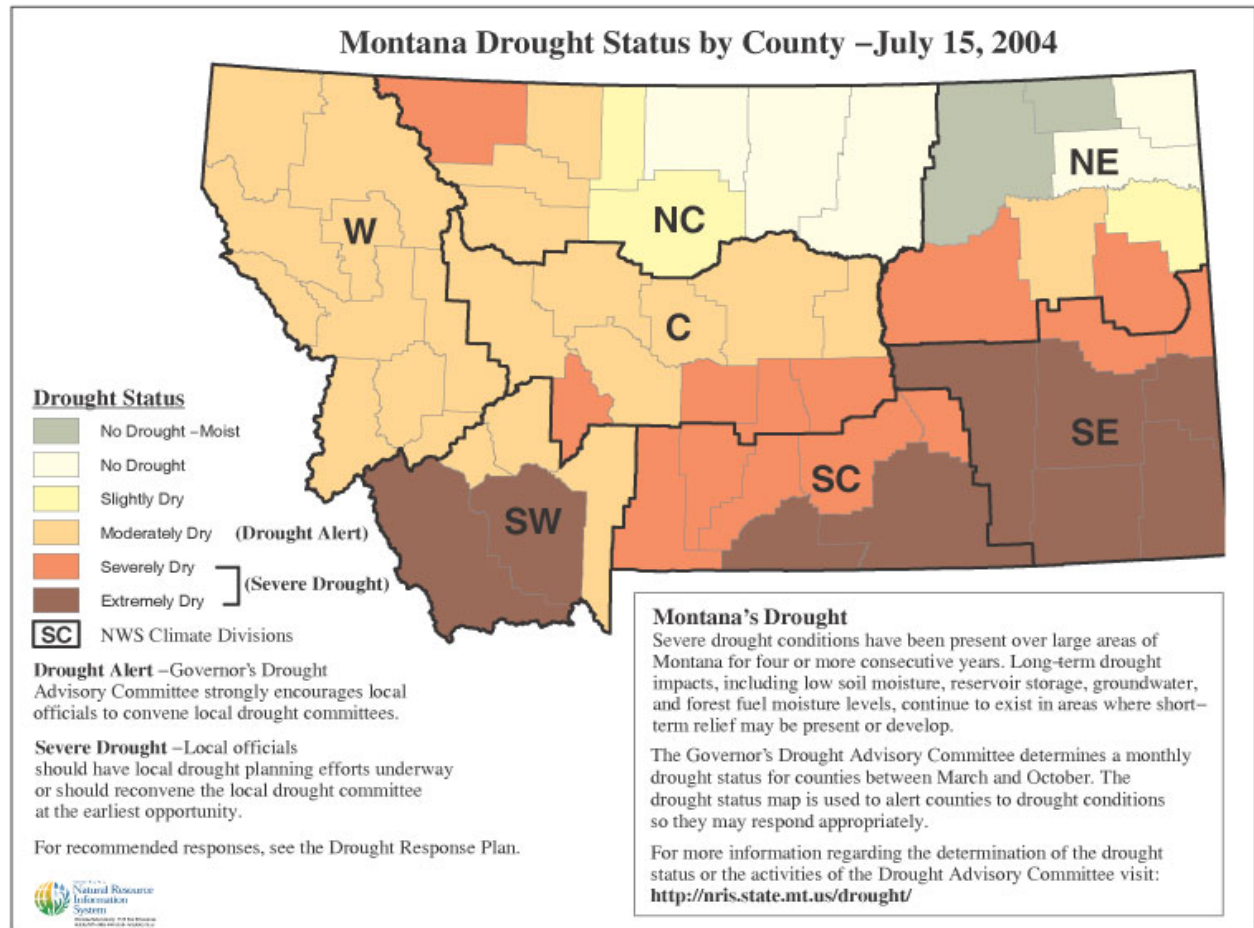


Figure 5. Montana Drought Status – July, 2004

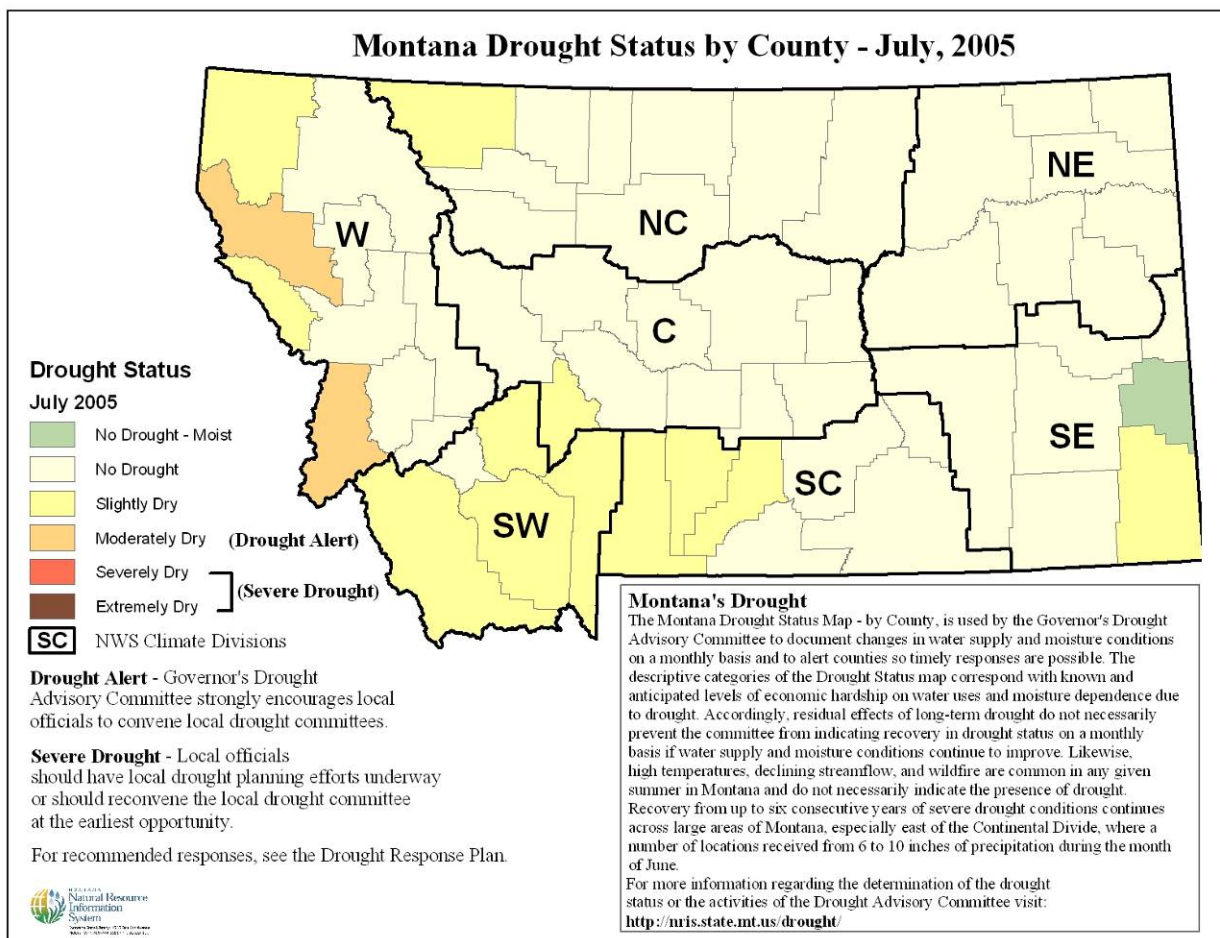


Figure 6. Montana Drought Status – July, 2005

11.0 RECOMMENDATIONS

The DEQ has a limited amount of resources and competing interests for implementing a statewide water quality monitoring network. Consequently, the added value of continuing the fixed-station network to detect trends in large streams may not be a high priority. Even so, there are a number of applications for fixed-station monitoring that are likely to be valuable to DEQ and our partners, stakeholders and the public. Recommendations for future implementation of the SWM monitoring network include the following:

- Expand the comprehensive report with fixed-station data collected by other entities.
- Expand the comprehensive report to include results from the Environmental Monitoring and Assessment Program (EMAP).
- Establish fixed-station monitoring of large rivers.
- Establish fixed-station monitoring of targeted subbasins that includes a random design and uses a rotating basin approach.
- Establish fixed-station monitoring on a subset of reference sites.
- Integrate the assessment of wetland-riparian areas with the fixed-station monitoring of streams.

11.1 Expand the Comprehensive Report with Fixed-Station Data Collected by Other Entities

DEQ could work with other entities to expand the comprehensive report for the SWM network by including fixed-station data and information that have been collected from the Clark Fork River, Blackfoot River, Flathead Basin, and Upper Missouri/Madison Rivers. This would provide the public a central location to access all of the available information about water quality status and trends that has been generated in Montana using a fixed-station monitoring approach.

11.2 Expand the Comprehensive Report to Include Results from the Environment Monitoring and Assessment Program (EMAP)

DEQ could expand the comprehensive report for the SWM network to include the results from the [Environmental Monitoring and Assessment Program \(EMAP\) Western Pilot \(EMAP-W\)](#). EMAP-W conducted a sample survey (or probability survey, often simply called ‘random’) of streams and rivers in 12 states of the western U.S., including Montana. This study occurred during the same time frame as the fixed-station monitoring (2000-2004).

The objective of EMAP-W was to assess the ecological condition of, and relative importance of stressors in, streams and rivers of the West at multiple scales. These objectives are similar to the objectives of the SWM fixed station network. Therefore the studies are likely to compliment one another. Also a [national wadeable stream assessment](#) for small streams was published in April 2006 (U.S. EPA 2006). The results of these studies could be compared.

11.3 Establish Fixed-Station Monitoring of Large Rivers

The statewide monitoring network could establish fixed-station monitoring on the large rivers including the lower Clark Fork, Lower Missouri, Lower Flathead, Yellowstone and Kootenai Rivers. Fixed stations could be established at targeted locations that have been sampled historically; above and below major tributaries, dams and major cities; or at location that represent major changes in land uses or ecoregions. A technical committee with participants from state and federal agencies, nonprofit groups and local universities could be formed to select or determine the goals and objectives, sampling locations, methods, parameters and frequency, and to earmark resources. The large river fixed-station monitoring network could be designed to meet the same objectives as the stream fixed-station monitoring network, but may also include other objectives such as determining upstream/downstream trends and providing a better understanding of cause and effect relationships.

11.4 Establish Fixed-Station Monitoring of Targeted Subbasins that Includes a Random Design and uses a Rotating Basin Approach

A fixed-station monitoring effort could be used on targeted subbasins or watersheds to characterize the water quality of these regions and meet multiple CWA objectives through implementing a monitoring effort that is designed to answer the following questions:

- To what extent is water quality changing over time and how does it vary within the subbasin or change from upstream/downstream locations?
- What are the problem areas and areas needing protection?
- What level of protection is needed (include monitoring of local reference sites)?
- How effective are restoration activities?
- What is the overall quality of waters in the subbasin?

The fixed-station monitoring effort could be implemented over time across the State of Montana using a rotating basin approach and could be supplemented with a probabilistic design and/or a landscape and field-based qualitative source assessment. The effort could provide important and presently unavailable information for point source permits, TMDL planning, effectiveness and ambient monitoring, and the development and interpretation of water quality standards. An advisory / technical committee could be formed including participants from Conservation Districts, watershed groups, state and federal agencies, nonprofit groups and/or universities to develop a sampling and analysis plan and data quality objectives for each targeted subbasin.

11.5 Establish Fixed-Station Monitoring on a Subset of Reference Sites

The Montana DEQ has developed a process to identify and assess reference sites for flowing waters ([Suplee et al. 2005](#)). Reference site conditions are established to represent the natural biological, physical and chemical integrity of a stream classification within a region. The reference site data is used to interpret water quality standards and is especially important for interpreting narrative standards that refer to “naturally occurring”.

The ability to assess reference conditions for some parameters is often complicated by year-year and seasonal climatic variability. However, temporal variability can be accounted for by establishing a fixed-station network that monitors a select number of reference sites that represent each stream classification on an annual basis. Over time, reference condition thresholds could be calibrated for wet and dry cycles. In addition, reference data would always be available that represents the current climatic conditions.

11.6 Integrate the Assessment of Wetland-Riparian Areas with the Fixed-Station Monitoring of Streams

The degradation of wetland-riparian areas can greatly affect watershed health and stream water quality because wetlands are such an integral part of watershed hydrology. Wetland-riparian areas perform as natural filters that improve water quality and provide many other watershed benefits including flood storage and erosion control. Stream water quality impairments such as elevated temperatures, sediment and nutrients can often be linked to the degradation of wetland-riparian areas. For this reason, the assessment of the wetland-riparian areas that are located within the watersheds of the fixed-station sites would improve the ability to assess stream conditions and to determine the sources and causes of water quality impairments. For additional information see: [“Integrating Wetland Inventory, Assessment and Monitoring into local watershed plans and Montana’s State Water Monitoring and Assessment Strategy”](#) (Apfelbeck 2006).

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APPENDIX A. FIELD WATER QUALITY DATA COLLECTED BY DEQ

DEQ field conductivity results, 2001-2005. Field was measured using a Horiba U-10 Water Quality Checker. An auto-calibration was used following DEQ SOP method 11.7.1.

Field Conductivity (us/cm)									
Basins	Site	STORET Station ID	Waterbody	2001	2002	2003	2004	2005	average
Missouri River Basin	1	M02BVHDR01	Beaverhead River near Dillon		584	673	1000	573	708
	2	M08BEAVR01	Beaverhead River at Twin Bridges	614	561	682	794	547	640
	3	M03BGHLR01	Big Hole River near Wise River			135	155	114	135
	4	M03BGHLR02	Big Hole River near Twin Bridges			241	212	226	226
	5	M08JEFFR01	Jefferson River near Three Forks	435	488	482	386	390	436
	6	M06MADNR01	Madison River near Three Forks			272	240	550	354
	7	M05GALLR01	Gallatin River at Logan	324					324
	8	M05GALLR02	Gallatin River near Three Forks		337	367	333	306	336
	9	M09MISSR01	Missouri River near Toston	348					348
	10	M09PRPEC01	Prickly Pear Creek near Clancy	140	145	207	199	163	171
	11	M12DRBNR01	Dearborn River at Craig	290	287	352	325	255	302
	12	M10SMTHR01	Smith River at Eden Bridge		302	345	387	312	337
	13a	M13SUNR01	Sun River at Sun River	797	650	540	768	715	694
	13b	USGS06089000	Sun River near Vaughn						
		M14TETOR01	Teton River near Loma	1590					1590
	14	M14TETOR02	Teton River near Loma - 1/4 mi upstream		1440	1350	1750	1510	1513
	15	M22JUDR01	Judith River 2 mi u/s confluence w/ Mi.R	788	628	739	960	760	775
	16	M24MUSSR01	Musselshell River at Harlowton		1010	790	924	905	907
	17	M28MUSSR01	Musselshell River near Mosby	519	368	842	2090	1000	964
	18	M37PEOPC01	Peoples Creek near Dodson						
	19	M45MILKR02	Milk River at Bjornberg Bridge		620			1210	915
	20	M45MILKR01	Milk River at Nashua	1620	600	1460	1080		1190
	21a	M47POPR01	Poplar River near Scooby	1580	1560	1710	1220	1580	1530
	21b	USGS06181000	Poplar River at Poplar						
	22	M50BMDYC01	Big Muddy Creek near Culbertson		3540				3540
	23	M51MISSR01	Missouri River near Culbertson	648					648
Yellowstone River Basin	24	Y03YELLR01	Yellowstone River near Livingston	220					220
	25	Y03SHIER01	Shields River near Livingston	440	440	448	378	384	418
	26	Y03BOULR01	Boulder River at Big Timber	202	239	158	71	124	159
	27	Y04STILR01	Stillwater River near Absarokee	154	178	85	84	75	115
	28	Y05CLFYR01	Clarks Fork of Yellowstone at Edgar	752	490	286	237	228	399
	29	Y11BGHNR01	Bighorn River near Hardin			1140	1060	1020	1073
	30	Y17BIGR01	Bighorn River at Bighorn	960	1160	1270	1010	1000	1080
	31	Y17ROSEC01	Rosebud Creek at Rosebud	1330	2380	2600			2103
	32	Y15TONGR01	Tongue River near Stateline		750				750
	33	Y16TONGR01	Tongue River near Brandenburg		580	452	645	391	517
	34	Y17TONGR01	Tongue River at Miles City	813	1040	631	789	474	749
	35	Y18POWDR01	Powder River near Moorhead		2850	1860	3630	1190	2383
	36	Y21POWDR01	Powder River near Locate	1550	2280	2190	3070	1320	2082
	37	Y23YELLR01	Yellowstone River at Sidney	820					820
Columbia River Basin	38	K01KOOTR01	Kootenai River near Libby Dam	256					256
	39	K02FISHR01	Fisher River near Libby	230	182	230	200	203	209
	40	K01YAAKR01	Yaak River near Troy	120	106	123	109	119	115
	41	C01LTBLR01	Little Blackfoot River at Garrison	286	214	247	330	257	267
	42	C02ROCKC01	Rock Creek near Clinton	141	133	113	159	127	135
	43	C02CKFKR02	Clark Fork River at Turah Fishing Access	358	325	272	393	305	331
	44	C03BLACR01	Blackfoot River near Bonner	250	214	225	293	236	244
	45	C05BITRR01	Bitterroot River near Darby			56	77	58	64
	46	C05BITTR01	Bitterroot R near Missoula	225	170	152	202	161	182
	47	C04CKFKR01	Clark Fork River at St Regis	249	186	278	248	239	240
	48	C06NFKFR01	NF Flathead River near Columbia Falls	197	177	197	183	196	190
	49	C07MFKFR01	MF Flathead River near West Glacier	173	148	171	162	159	163
	50	C08FRSFK01	SF Flathead River near Spotted Bear		175	199	183	189	187
	51	C09WHTFR01	Whitefish River near Kalispell	189	163	182	165	165	173
	52	C10SWANR01	Swan River near Bigfork	155	125	132	144	149	141
	53	C12FLATR01	Flathead River near Perma	183					183

DEQ water temperature results 2001-2005. Water temperature was collected using a Horiba U-10 Water Quality Checker following DEQ SOP method 11.7.1. Suspect temperature values errors are highlighted.

Water Temperature (Celcius)									
Basins	Site	STORET Station ID	Waterbody	2001	2002	2003	2004	2005	
Missouri River Basin	1	M02BVH0R01	Beaverhead River near Dillon		16.9	18.3	18.3	18.2	
	2	M08BEAVR01	Beaverhead River at Twin Bridges	18.1	18.2	19.4	16.7	20.0	
	3	M03BGHLR01	Big Hole River near Wise River			13.6	13.4	23.5	
	4	M03BGHLR02	Big Hole River near Twin Bridges			21.7	18.5	23.4	
	5	M08JEFFR01	Jefferson River near Three Forks	25.3	12.2	20.6	20.4	22.6	
	6	M06MADNR01	Madison River near Three Forks			21.5	17.3	20.0	
	7	M05GALLR01	Gallatin River at Logan	23.2					
	8	M05GALLR02	Gallatin River near Three Forks		20.6	18.9	17.7	18.3	
	9	M09MISSR01	Missouri River near Toston	24.4					
	10	M09PRPEC01	Prickly Pear Creek near Clancy	9.0	13.1	17.0	35.0	12.0	
	11	M12DRBNR01	Dearborn River at Craig	11.0	21.0	15.9	13.3	12.7	
	12	M10SMTHR01	Smith River at Eden Bridge		18.5	23.1	20.3	21.6	
	13a	M13SUNR01	Sun River at Sun River	20.7	20.5	18.9	18.4	22.6	
	13b	USGS06089000	Sun River near Vaughn						
		M14TETOR01	Teton River near Loma	29.6					
		M14TETOR02	Teton River near Loma - 1/4 mi upstream		24.3	24.2	22.1	26.6	
		M22JUDR01	Judith River 2 mi u/s confluence w/ Mi. R	27.3	8.5	15.5	24.5	20.5	
		M24MUSSR01	Musselshell River at Harlowton		19.2	13.0	19.1	21.2	
		M28MUSSR01	Musselshell River near Mosby	24.5	29.0	29.0	20.2	23.3	
		M37PEOPC01	Peoples Creek near Dodson						
		M45MILKR02	Milk River at Bjornberg Bridge		23.3			21.0	
		M45MILKR01	Milk River at Nashua	15.7	23.0	23.3	16.4		
		21a	M47POPR01	Poplar River near Scooby	9.1	21.7	26.6	17.3	17.9
		21b	USGS06181000	Poplar River at Poplar					
		22	M50BMDYC01	Big Muddy Creek near Culbertson		26.2			
		23	M51MISSR01	Missouri River near Culbertson	14.1				
Yellowstone River Basin	24	Y03YELLR01	Yellowstone River near Livingston	21.7					
	25	Y03SHIER01	Shields River near Livingston	22.9	16.0	18.7	14.0	19.5	
	26	Y03BOULR01	Boulder River at Big Timber	16.7	18.9	17.0	11.3	16.5	
	27	Y04STILR01	Stillwater River near Absarokee	18.3	13.2	15.4	12.3	19.5	
	28	Y05CLFYR01	Clarks Fork of Yellowstone at Edgar	25.0	16.8	19.7	14.2	20.9	
	29	Y11BGHNR01	Bighorn River near Hardin			11.6	12.2	16.7	
	30	Y17BIGH01	Bighorn River at Bighorn	20.6	19.5	25.5	15.6	17.7	
	31	Y17ROSEC01	Rosebud Creek at Rosebud	25.3	27.0	30.5			
	32	Y15TONGR01	Tongue River near Stateline		24.9				
	33	Y16TONGR01	Tongue River near Brandenburg		26.7	24.9	17.6	29.4	
	34	Y17TONGR01	Tongue River at Miles City	26.6	21.1	22.3	16.5	26.0	
	35	Y18POWDR01	Powder River near Moorhead		19.8	21.1	12.1	25.5	
	36	Y21POWDR01	Powder River near Locate	24.3	25.4	22.0	17.2	29.5	
	37	Y23YELLR01	Yellowstone River at Sidney	14.7					
Columbia River Basin	38	K01KOOTR01	Kootenai River near Libby Dam	15.5					
	39	K02FISHR01	Fisher River near Libby	23.5	20.1	16.0	21.0	21.9	
	40	K01YAAKR01	Yaak River near Troy	19.4	15.3	18.2	18.3	23.2	
	41	C01LTBLR01	Little Blackfoot River at Garrison	19.1	14.4	20.1	18.4	14.8	
	42	C02ROCKC01	Rock Creek near Clinton	15.7	12.1	17.0	16.0	16.5	
	43	C02CKFKR02	Clark Fork River at Turah Fishing Access	18.8	15.6	19.6	18.7	19.1	
	44	C03BLACR01	Blackfoot River near Bonner	19.4	16.4	20.8	20.1	20.0	
	45	C05BITRR01	Bitterroot River near Darby			19.5	17.7	18.2	
	46	C05BITTR01	Bitterroot R near Missoula	17.1	14.7	20.2	18.4	19.8	
	47	C04CKFKR01	Clark Fork River at St Regis	20.4	17.1	17.6	18.3	21.1	
	48	C06NFKFR01	NF Flathead River near Columbia Falls	18.9	14.8	13.9	15.0	17.2	
	49	C07MFKFR01	MF Flathead River near West Glacier	18.2	15.1	13.0	12.6	15.6	
	50	C08FRSFK01	SF Flathead River near Spotted Bear		15.4	17.9	16.1	20.1	
	51	C09WHTFR01	Whitefish River near Kalispell	21.1	17.8	20.7	20.5	23.1	
	52	C10SWANR01	Swan River near Bigfork	21.3	19.4	20.3	18.8	21.6	
	53	C12FLATR01	Flathead River near Perma	21.8					

DEQ dissolved oxygen results, 2001-2005. Dissolved oxygen was measured following DEQ SOP 11.7.1. The dissolved oxygen values highlighted with tan are suspect values that are likely caused by calibration error. Values highlighted with yellow are suspect values where the probe was likely buried in sediment. Dissolved oxygen measurements were not corrected for changes in barometric pressure.

Dissolved Oxygen (mg/L)										
Basins	Site	STORET Station ID	Waterbody	2001	2002	2003	2004	2005	average	
Missouri River Basin	1	M02BVHDR01	Beaverhead River near Dillon		9.0	12.1	11.6	12.6	11.3	
	2	M08BEAVR01	Beaverhead River at Twin Bridges	12.1	13.9	11.4	11.3	14.1	12.6	
	3	M03BGHLR01	Big Hole River near Wise River			8.9	10.2	11.3	10.1	
	4	M03BGHLR02	Big Hole River near Twin Bridges			13.2	12.1	13.9	13.1	
	5	M08JEFFR01	Jefferson River near Three Forks	10.3	11.8	8.0	9.5	11.8	10.3	
	6	M06MADNR01	Madison River near Three Forks			11.4	10.2	13.1	11.6	
	7	M05GALLR01	Gallatin River at Logan	17.5					17.5	
	8	M05GALLR02	Gallatin River near Three Forks		11.7	8.2	9.1	10.5	9.9	
	9	M09MISSR01	Missouri River near Toston	11.5					11.5	
	10	M09PRPEC01	Prickly Pear Creek near Clancy	14.9	10.7	10.7	11.9	11.3	11.9	
	11	M12DRBNR01	Dearborn River at Craig	12.5	8.7	11.2	11.0	11.4	11.0	
	12	M10SMTHR01	Smith River at Eden Bridge		11.3	9.2	10.0	10.6	10.3	
	13a	M13SUNR01	Sun River at Sun River	10.7	8.0	10.0	12.5	11.0	10.4	
	13b	USGS06089000	Sun River near Vaughn							
		M14TETOR01	Teton River near Loma	7.3					7.3	
		M14TETOR02	Teton River near Loma - 1/4 mi upstream		9.0	9.1	9.8	8.8	9.2	
		M22JUDR01	Judith River 2 mi u/s confluence w/ Mi. R	8.4	13.3	9.0	9.1	9.5	9.9	
		M24MUSSR01	Musselshell River at Harlowton		12.8	12.0	11.0	10.9	11.7	
		M28MUSSR01	Musselshell River near Mosby	11.2	7.3	2.7	10.8	8.4	8.1	
		M37PEOPC01	Peoples Creek near Dodson							
		M45MILKR02	Milk River at Bjornberg Bridge		8.3			8.6	8.5	
		M45MILKR01	Milk River at Nashua	11.7	8.9	7.7	9.4		9.4	
		21a	M47POPR01	Poplar River near Scooby	13.2	9.7	11.2	11.3	8.3	10.7
	21b	USGS06181000	Poplar River at Poplar							
	22	M50BMDYC01	Big Muddy Creek near Culbertson		11.7				11.7	
	23	M51MISSR01	Missouri River near Culbertson	10.1					10.1	
Yellowstone River Basin	24	Y03YELLR01	Yellowstone River near Livingston	9.1					9.1	
	25	Y03SHIER01	Shields River near Livingston	8.8	11.5	10.2	10.5	9.9	10.2	
	26	Y03BOULR01	Boulder River at Big Timber	8.1	9.7	10.2	11.5	10.4	10.0	
	27	Y04STILR01	Stillwater River near Absarokee	10.4	9.7	11.1	11.7	10.5	10.7	
	28	Y05CLFYR01	Clarks Fork of Yellowstone at Edgar	10.4	11.2	12.0	9.7	10.3	10.7	
	29	Y11BGHNR01	Bighorn River near Hardin			11.9	14.4	15.7	14.0	
	30	Y17BIGH01	Bighorn River at Bighorn	10.4	12.5	10.9	11.7	15.3	12.2	
	31	Y17ROSEC01	Rosebud Creek at Rosebud	8.3	11.2	0.1			6.5	
	32	Y15TONGR01	Tongue River near Stateline		10.0				10.0	
	33	Y16TONGR01	Tongue River near Brandenburg		8.0	8.6	10.2	8.0	8.7	
	34	Y17TONGR01	Tongue River at Miles City	7.0	7.0	7.9	9.3	8.3	7.9	
	35	Y18POWDR01	Powder River near Moorhead		8.7	9.2	11.0	8.7	9.4	
	36	Y21POWDR01	Powder River near Locate	7.4	7.5	8.9	9.9	7.8	8.3	
	37	Y23YELLR01	Yellowstone River at Sidney	9.0					9.0	
Columbia River Basin	38	K01KOOTR01	Kootenai River near Libby Dam	11.7					11.7	
	39	K02FISHR01	Fisher River near Libby	9.1	11.1	9.8	10.3	9.3	9.9	
	40	K01YAAKR01	Yaak River near Troy	8.2	9.6	9.9	9.8	8.8	9.3	
	41	C01LTBLR01	Little Blackfoot River at Garrison	10.9	10.4	9.5	11.2	10.5	10.5	
	42	C02ROCKC01	Rock Creek near Clinton	12.0	11.9	10.5	10.6	10.9	11.2	
	43	C02CKFKR02	Clark Fork River at Turah Fishing Access	15.5	11.9	14.1	11.9	11.6	13.0	
	44	C03BLACR01	Blackfoot River near Bonner	14.0	11.6	11.0	10.4	10.3	11.5	
	45	C05BITRR01	Bitterroot River near Darby			10.0	10.1	10.6	10.2	
	46	C05BITTR01	Bitterroot R near Missoula	12.3	8.3	9.7	9.7	10.1	10.0	
	47	C04CKFKR01	Clark Fork River at St Regis	11.7	9.8	8.3	9.0	10.0	9.8	
	48	C06NFKFR01	NF Flathead River near Columbia Falls	14.3	10.3	10.6	10.8	10.3	11.3	
	49	C07MFKFR01	MF Flathead River near West Glacier	14.4	10.8	10.3	10.8	10.4	11.3	
	50	C08FRSFK01	SF Flathead River near Spotted Bear		10.2	10.2	10.9	9.6	10.2	
	51	C09WHTFR01	Whitefish River near Kalispell	12.7	10.1	9.4	10.5	11.0	10.7	
	52	C10SWANR01	Swan River near Bigfork	9.7	9.4	9.7	11.0	9.6	9.9	
	53	C12FLATR01	Flathead River near Perma	9.8					9.8	

DEQ field pH results, 2001-2005. Field pH was measured using a Horiba U-10 Water Quality Checker. An auto-calibration was used following DEQ SOP method 11.7.1. The pH values that are highlighted are suspect values that are likely caused by calibration error.

Field pH									
Basins	Site	STORET Station ID	Waterbody	2001	2002	2003	2004	2005	average
Missouri River Basin	1	M02BVHDR01	Beaverhead River near Dillon		7.7	7.7	7.9	8.2	7.9
	2	M08BEAVR01	Beaverhead River at Twin Bridges	8.0	8.3	7.9	7.7	8.2	8.0
	3	M03BGHLR01	Big Hole River near Wise River			6.6	6.7	9.2	7.5
	4	M03BGHLR02	Big Hole River near Twin Bridges			8.4	8.1	8.3	8.3
	5	M08JEFFR01	Jefferson River near Three Forks	8.2	7.8	7.9	7.9	8.1	8.0
	6	M06MADNR01	Madison River near Three Forks			8.2	7.6	8.5	8.1
	7	M05GALLR01	Gallatin River at Logan	8.8					8.8
	8	M05GALLR02	Gallatin River near Three Forks		8.0	7.4	7.7	7.9	7.8
	9	M09MISSR01	Missouri River near Toston	8.6					8.6
	10	M09PRPEC01	Prickly Pear Creek near Clancy	6.6	7.3	8.0	6.6	7.0	7.1
	11	M12DRBNR01	Dearborn River at Craig	8.1	8.0	8.1	7.7	8.1	8.0
	12	M10SMTHR01	Smith River at Eden Bridge		8.2	8.2	8.0	8.1	8.1
	13a	M13SUNR01	Sun River at Sun River	8.5	7.3	8.1	8.0	7.9	8.0
	13b	USGS06089000	Sun River near Vaughn						
		M14TETOR01	Teton River near Loma	7.8					7.8
	14	M14TETOR02	Teton River near Loma - 1/4 mi upstream		7.9	8.3	8.1	8.2	8.1
	15	M22JUDDR01	Judith River 2 mi u/s confluence w/ Mi. R	8.1	8.1	8.2	7.9	7.8	8.0
	16	M24MUSSR01	Musselshell River at Harlowton		7.9	8.0	8.0	8.0	8.0
	17	M28MUSSR01	Musselshell River near Mosby	8.1	7.9	8.0	8.2	8.0	8.0
	18	M37PEOPC01	Peoples Creek near Dodson						
	19	M45MILKR02	Milk River at Bjornberg Bridge		7.9			8.0	8.0
	20	M45MILKR01	Milk River at Nashua	8.9	7.6	8.0	7.4		8.0
	21a	M47POPR01	Poplar River near Scooby	8.9	8.5	8.7	8.1	8.7	8.6
21b	USGS06181000	Poplar River at Poplar							
22	M50BMDYC01	Big Muddy Creek near Culbertson		8.5				8.5	
23	M51MISSR01	Missouri River near Culbertson	8.6					8.6	
Yellowstone River Basin	24	Y03YELLR01	Yellowstone River near Livingston	7.9					7.9
	25	Y03SHIER01	Shields River near Livingston	8.1	7.7	8.1	8.0	8.0	8.0
	26	Y03BOULR01	Boulder River at Big Timber	7.8	7.2	8.1	5.5	7.6	7.2
	27	Y04STILR01	Stillwater River near Absarokee	7.4	7.2	7.8	6.2	8.2	7.4
	28	Y05CLFYR01	Clarks Fork of Yellowstone at Edgar	8.2	7.8	8.2	6.7	7.5	7.7
	29	Y11BGHNR01	Bighorn River near Hardin			7.9	8.0	8.4	8.1
	30	Y17BIGH01	Bighorn River at Bighorn	7.9	7.9	8.1	8.1	8.2	8.0
	31	Y17ROSEC01	Rosebud Creek at Rosebud	7.7	8.2	7.3			7.7
	32	Y15TONGR01	Tongue River near Stateline		8.3				8.3
	33	Y16TONGR01	Tongue River near Brandenburg		8.0	8.0	7.7	8.2	8.0
	34	Y17TONGR01	Tongue River at Miles City	7.9	7.8	7.8	8.1	7.9	7.9
	35	Y18POWDR01	Powder River near Moorhead		8.0	8.1	8.0	8.2	8.1
	36	Y21POWDR01	Powder River near Locate	7.8	7.8	8.0	8.0	8.8	8.1
	37	Y23YELLR01	Yellowstone River at Sidney	8.6					8.6
Columbia River Basin	38	K01KOOTR01	Kootenai River near Libby Dam	7.9					7.9
	39	K02FISHR01	Fisher River near Libby	7.7	7.9	7.9	7.4	7.9	7.8
	40	K01YAAKR01	Yaak River near Troy	7.8	7.0	7.9	7.3	8.0	7.6
	41	C01LTBLR01	Little Blackfoot River at Garrison	8.1	7.5	7.9	7.6	7.4	7.7
	42	C02ROCKC01	Rock Creek near Clinton	6.9	7.2	7.4	6.0	7.6	7.0
	43	C02CKFKR02	Clark Fork River at Turah Fishing Access	8.5	8.2	7.8	7.9	8.2	8.1
	44	C03BLACR01	Blackfoot River near Bonner	8.5	8.1	8.2	8.1	8.1	8.2
	45	C05BITRR01	Bitterroot River near Darby			6.8	6.0	7.8	6.9
	46	C05BITTR01	Bitterroot R near Missoula	7.7	7.0	7.7	7.0	7.6	7.4
	47	C04CKFKR01	Clark Fork River at St Regis	8.4	7.2	7.9	7.8	8.2	7.9
	48	C06NFKFR01	NF Flathead River near Columbia Falls	7.8	7.6	7.8	7.9	8.2	7.9
	49	C07MFKFR01	MF Flathead River near West Glacier	7.6	7.8	7.5	6.9	7.8	7.5
	50	C08FRSFK01	SF Flathead River near Spotted Bear		7.6	8.2	7.9	8.3	8.0
	51	C09WHTFR01	Whitefish River near Kalispell	7.1	7.5	8.0	8.3	8.4	7.9
	52	C10SWANR01	Swan River near Bigfork	7.2	7.4	8.2	7.3	7.8	7.6
	53	C12FLATR01	Flathead River near Perma	8.1					8.1

APPENDIX B. BED SEDIMENT METALS RESULTS

DEQ bed-sediment metals results, 2001. Bed-sediment metals data collected in 2001 following DEQ SOP method 11.8.5. The values that are highlighted show elevated metal concentrations.

	SEDIMENT METALS (ug/g)															
WATERBODY	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	Tl	Zn
MISSOURI RIVER BASIN																
BEAVERHEAD RIVER NEAR TWIN BRIDGES	8160	<5	<5	126	<5	<1	14	12	10200	10	746	10	<5	<5	<5	44
JEFFERSON RIVER NEAR THREE FORKS	8120	<5	6	182	<5	1	14	32	11000	19	799	9	<5	<5	<5	140
GALLATIN RIVER AT LOGAN	10300	<5	<5	208	<5	<1	22	16	12900	10	445	16	<5	<5	<5	49
MISSOURI RIVER AT TOSTON	10400	<5	11	174	<5	<1	18	21	12700	15	709	14	<5	<5	<5	79
PRICKLY PEAR CREEK NEAR CLANCY	8610	<5	96	142	<5	8	10	134	17800	436	1570	9	<5	<5	<20	1230
DEARBORN NEAR CRAIG	7310	<5	<5	294	<5	<1	6	13	8400	11	364	9	<5	<5	<20	40
SUN RIVER AT SUN RIVER	8450	<5	6	190	<5	<1	7	13	11100	10	283	10	<5	<5	<5	50
TETON RIVER AT LOMA	6280	<5	6	216	<5	<1	9	21	11900	10	427	15	<5	<5	<5	59
JUDITH RIVER 2 MILES ABOVE MISSOURI R.	7820	<5	7	120	<5	<1	11	22	15000	13	213	17	<5	<5	<5	69
MUSSELLSHELL AT MOSBY	8050	<5	<5	135	<5	<1	10	18	13700	11	442	16	<5	<5	<5	61
MILK RIVER AT NASHUA	11600	<5	10	229	<5	<1	14	20	17300	15	533	23	<5	<5	<5	76
POPLAR RIVER NEAR SCOBEE	9670	<5	9	184	<5	<1	12	15	14100	14	426	14	<5	<5	<5	51
MISSOURI RIVER NEAR CULBERTSON	8690	<5	13	254	<5	<1	12	19	14400	12	301	19	<5	<5	<5	64
YELLOWSTONE RIVER BASIN																
YELLOWSTONE RIVER NEAR LIVINGSTON	13000	<5	21	196	<5	1	14	32	28900	14	533	35	<5	<5	<20	62
SHIELDS RIVER NEAR LIVINGSTON	13300	<5	<5	208	<5	<1	18	17	15300	13	647	20	<5	<5	<20	51
BOULDER RIVER AT BIG TIMBER	11000	<5	7	209	<5	<1	38	22	15600	15	295	31	<5	<5	<20	48
STILLWATER RIVER NEAR ABSAROOKEE	10000	<5	<5	156	<5	<1	22	25	13300	12	261	20	<5	<5	<20	52
CLARKS FORK OF YELLOWSTONE AT EDGAR	9000	<5	<5	117	<5	<1	15	16	14100	10	389	18	<5	<5	<20	48
BIGHORN RIVER AT BIGHORN	8000	<5	10	146	<5	<1	7	15	11300	11	243	14	<5	<5	<20	57
ROSEBUD CREEK AT ROSEBUD	13000	<5	5	170	<5	<1	16	24	16500	16	318	23	<5	<5	<20	68
TONGUE RIVER AT MILES CITY	14000	<5	<5	170	<5	<1	19	24	14400	19	284	26	<5	<5	<20	69
POWDER RIVER NEAR LOCATE	12000	<5	5	156	<5	<1	14	19	14400	17	241	21	<5	<5	<20	73
YELLOWSTONE RIVER AT SIDNEY	10800	<5	7	148	<5	<1	15	20	14200	14	257	21	<5	<5	<5	60
COLUMBIA RIVER BASIN																
KOOTENAI RIVER NEAR LIBBY DAM	6310	<5	8	97	<5	<1	10	11	11900	12	359	13	<5	<5	<5	52
FISHER RIVER NEAR LIBBY	7510	<5	<5	108	<5	<1	8	12	11200	10	300	12	<5	<5	<5	43
YAAK RIVER NEAR TROY	7450	<5	<5	70	<5	<1	7	11	8180	9	211	7	<5	<5	<5	32
LITTLE BLACKFOOT RIVER NEAR GARRISON	8800	<5	13	172	<5	<1	15	37	9000	25	499	13	<5	<5	<5	122
ROCK CREEK NEAR CLINTON	8270	<5	<5	254	<5	<1	8	10	8820	9	285	7	<5	<5	<5	30
CLARK FORK AT TURAH	9140	<5	30	223	<5	3	9	315	8000	63	476	9	<5	<5	<5	628
BLACKFOOT RIVER NEAR BONNER	7670	<5	6	323	<5	<1	7	20	3300	11	234	9	<5	<5	<5	49
BITTERROOT RIVER NEAR MISSOULA	4800	<5	<5	231	<5	1	11	17	10800	15	348	8	<5	<5	<5	66
CLARK FORK AT ST REGIS	4000	<5	10	238	<5	1	9	93	8400	34	184	9	<5	<5	<5	252
N. FORK FLATHEAD NEAR COL. FALLS	7310	<5	<5	136	<5	<1	6	11	10500	9	264	10	<5	<5	<5	43
MIDDLE FORK FLATHEAD NEAR W. GLACIER	8180	<5	<5	207	<5	<1	7	17	10700	10	261	11	<5	<5	<5	38
WHITEFISH RIVER NEAR KALISPELL	8900	<5	<5	161	<5	<1	6	13	9700	14	299	9	<5	<5	<5	47
SWAN RIVER NEAR BIG FORK	11500	<5	<5	198	<5	<1	9	20	12400	16	321	12	<5	<5	<5	42
FLATHEAD RIVER NEAR PERMA	8690	<5	<5	143	<5	<1	8	13	9640	10	303	10	<5	<5	<5	39

APPENDIX C. DEQ SITE CLASSIFICATIONS

DEQ formed a small committee in 2006 that was composed of technical staff from the Water Quality Standards Section to evaluate the physical and chemical data that were collected by the SWM program. The committee used best professional judgment (BPJ) to classify the condition of the SWM sites as having non/slight, moderate or severe degree of impairment; and as having non-impairment or impairment of aquatic life uses. These classifications are summarized in the following table. The committee's site classifications of non-impairment and impairment were used to test the biological assessment methods (Bollman and Teply 2006).

The DEQ site classifications only represent data collected from one location. For this reason, the DEQ site classifications of non-impaired and impaired were compared to the 2006 303(d) list which assesses an entire stream segment. The additional information obtained from the 2006 303(d) list was used to augment the DEQ site classifications. This changed the original site classifications for the Bitterroot River near Darby, Boulder River at Boulder, and the Big Hole River near Wisdom from non-impairment to impairment. However, two DEQ site classifications that were used to evaluate the biological assessments and did not agree with the 2006 303(d) list were not changed. These sites were the Dearborn River near Craig and the Swan River near Bigfork which were classified as having non-impairment by DEQ but were listed as having impairment on the 2006 303(d) list. For this reason, the DEQ site classifications had 90% agreement with the 2006 303(d) list on impairment of aquatic life uses. However, approximately 20% of the SWM sites/stream reaches were not assessed for 303(d) purposes and could not be compared to DEQ's site classifications. The sites that were not assessed on the 2006 303(d) list were located on the Powder, Tongue, Milk, Bighorn, and Yaak Rivers.

STATEWIDE MONITORING PROJECT				
The sites were ranked using the 2006 303(d) list and the SWM data to determine impairment/nonimpairment.				
The rankings were determined by using BPJ to evaluate each site using the physical and chemical data.				
The degree of impairment and the level of confidence in the decision were also documented. (This is not a 303(d) Assessment)				
The possible causes of impairment are listed and ranked from most to least influential using BPJ. (This is not a 303(d) Assessment)				
Missouri River Basin:				
Site	ALU Impairment	Degree	Confidence	Possible Causes (ranked)
Beaverhead near Dillon	Yes	Moderate	High	nutrients, habitat, flow
Beaverhead near Twin Bridges	Yes	Moderate	High	nutrients habitat, flow, sediment, temperature
Big Hole at Wise River	Yes	Moderate	Moderate	temp, flow, habitat, metals
Big Hole at Twin Bridges	Yes	Moderate	High	temp, flow, habitat, metals
Jefferson	Yes	Severe	High	flow, temp, habitat, sediment, nutrients, metals
Madison	Yes	Moderate	Moderate	Temp, sediment, habitat
Gallatin	Yes	Moderate	High	Nutrients, flow
Missouri at Toston	Yes	Moderate	Moderate	Temp, Habitat, sediment, flow
Prickly Pear	Yes	Severe	High	Metals, habitat, sediment
Dearborn	No	slight	Moderate	Listed for Temp?
Smith	Yes	Moderate	Moderate	flow, temp, habitat, nutrients
Sun	Yes	Moderate	Moderate	Flow, habitat, temp, sediment, nutrients
Teton	Yes	Severe	High	Flow, sediment, salinity
Judith	Yes	slight	Moderate	Riparian degradation, temp
Musselshell at Mosby	Yes	Severe	High	Flow, habitat, sediment
Musselshell at Harlowtown	Yes	moderate	Moderate	Flow, nutrients, sediment, habitat
Peoples Creek	Yes	moderate	High	habitat, flow, salinity
Milk River	Yes	Severe	Moderate	Habitat, flow, nutrients
Poplar	Yes	Slight	Low	nutrients; sediment, temp (natural sources)
Big Muddy	Yes	moderate	Moderate	Flow, nutrients, sediment
Missouri near Culbertson	Yes	Moderate	High	Flow, temp
Yellowstone River Basin				
Site	ALU Impairment	Degree	Confidence	Possible Causes (ranked)
Yellowstone River@ Livingston	No	Slight	moderate	
Shields River	Yes	Moderate	moderate	Flow, nutrients
Boulder	Yes	Slight	moderate	Flow, metals
Stillwater	Yes	slight	moderate	Flow metals
Clarks Fork of Yellowstone	Yes	Severe	High	Nutrient, sediment, flow
Big Horn near Big Horn	Yes	moderate	moderate	nutrients
Big Horn near Hardin	Yes	moderate	moderate	nutrients
Rosebud	Yes	Severe	High	flow, habitat, salinity
Tongue @ miles city	Yes	Severe	High	flow, sediment, nutrients, salinity
Tongue near Brandenburg	No	slight	low	
Tongue River at Stateline	Yes	moderate	moderate	nutrients
Powder at Locate	Yes	moderate	moderate	flow, salinity
Powder River at Moorhead	No	slight	low	
Yellowstone at Sidney	Yes	moderate	High	flow, sediment, metals, pH
Columbia River Basin				
Site	ALU Impairment	Degree	Confidence	Possible Causes (ranked)
Kootenai	Yes	moderate	low	Flow, temp
Fisher River	Yes	moderate	moderate	habitat, flow, sediment
Yaak River	No	slight	low	
Little Blackfoot	Yes	moderate	high	flow, habitat, sediment, nutrients, metals
Rock Creek	No	slight	moderate	
Clark Fork @ Turah	Yes	moderate	High	metals, nutrients, habitat
Blackfoot	No	Slight	moderate	
Bitterroot at Missoula	Yes	moderate	moderate	nitrogen, sediment, habitat
Bitterroot at Darby	Yes	Slight	Low	Copper, habitat
Clark Fork at St. Regis	Yes	moderate	moderate	nitrogen, copper
Middle Fork Flathead	No	slight	High	
North Fork Flathead	No	slight	High	
South Fork Flathead	No	Slight	High	
Whitefish River	Yes	moderate	moderate	nutrients, temp, metals
Swan River	No	slight	moderate	listed for copper based on one exceedence.
Flathead at Perma	Yes	moderate	High	flow, temp, sediment

APPENDIX D. WATER QUALITY DATA THAT WAS COLLECTED BY DEQ IN 2004 AND 2005

[Water Quality Data](#)